Railway Age

DAILY EDITION

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EDITORIAL

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Getting the Most Out of the Exhibit

While the individual exhibits at the Coliseum this year are more than usually interesting and instructive, there is more to learn from a visit to the exhibit than the merits of the various devices on display and how they may be applied to special problems. There is a big lesson to be learned from the exhibition as a whole, as will be evidenced to the careful observer if he will study the distribution of the visitors and the character of the exhibits under study. Almost invariably the larger groups of individuals will be found surrounding exhibits of labor-saving devices. This is a sign of the times and should start every visitor on a careful introspection to make sure that he is doing his part towards conserving the man-power of the nation.

Subsidence and Shrinkage in Embankments

Subsidence and shrinkage of embankments are often confused, one with the other. There is, however, a complete distinction between the two, as is brought out clearly in this year's report of the Committee on Roadway. The committee defines subsidence as that portion of an embankment which has settled below the original surface of the ground. Shrinkage, on the other hand, is the quantitative relation between materials measured in excavation and embankment and is a variable, depending on the character of the material used, becoming swell in the case of rock, which occupies more space in embankment than in excavation. Subsidence may be present and an important factor for consideration in embankments constructed from materials of any character. In its investigation during the past year the committee has accumulated a large amount of data on these topics and the information set forth in its report should prove of great value, particularly to engineers concerned with valuation matters. These investigations should be continued and carried out to definite conclusions for presentation to the association at a subsequent convention.

Some Tangible Results

Appendix D to the report of the Roadway Committee embodies the first specific use to be made of the work of the Special Committee on Stresses in Railroad Track. The subcommittee on unit pressures allowable on roadbeds offers a method for determining the maximum pressures transmitted to the roadbed through various depths of ballast. While this still leaves much to conjecture, it represents definite progress. With the growing density of traffic and the increasing cost of maintenance, all conditions point to the use of heavier—much heavier—tracks in the future. Even under present practice track has become very expensive, while future construction unquestionably will cost much more. Consequently, it will no longer suffice simply to make arbitrary increases in the weight of rail, the number and size of ties, the depth of ballast, or the width of the roadbed. It is necessary to know which feature or detail of the structure is most in need of strengthening. It is only in this way that the increase in strength and permanence may be made at the least cost. There is no economy in making any component part disproportionately weak or disproportionately strong as compared to any other part. Herein lies one of the greatest fields for the application of the scientific conclusions to be derived from the study of stresses in track.

A Comprehensive Work Well Done

The Committee on Iron and Steel Structures has just completed a monumental work in the new Specification for Iron and Steel Structures, which will be a fitting successor for the earlier specification of the American Railway Engineering Association for steel bridges, which is now generally used in this country, while serving also as a model in many other parts of the world. That the members in attendance at the meeting yesterday morning fully appreciated the painstaking care and extended effort which the committee bestowed on its task is evidenced by the reluctance displayed in approving any of the numerous amendments offered in the course of the discussion. The new specification represents progress. It differs from its predecessors in the introduction of modifications based on the results of scientific investigation and the incorporation of refinements in design founded on structures in service. As pointed out by Chairman Selby, the specification is designed to take advantage of these refinements in obtaining greater economy of design. "It is not the intention," he said, "to cover up any fictitious margin for overloading—the margin of overloading is only a proper one"; the gain therefore is in economy as well as in excellence. This is an important point to keep in mind in any thought of shaving down live loadings in connection with the use of the new specifications.

Retain the Tie Specifications

The American Railway Engineering Association acted wisely yesterday afternoon in approving the recommendation of the tie committee to the effect that the present tie specifications of the United States Railroad Administration shall be continued. While the discussion of this subject was interesting, it brought out little information which was new to those who have been in close touch with the subject. It did, however, bring in contrast the conflicting interests of the different railroads. This was brought out specifically by the statement of one chief engineer that his road would not adopt these specifications, even though the association approved them. The specifications have been a source of contention ever since their issuance 18 months ago. Without question, they contain defects. At the same time they are the specifications under which all of the railroads have purchased ties and under which all of the manufacturers have produced them for over a

year, and are the first specifications which have ever been followed with any degree of uniformity by any considerable number of roads. The absence of or the ignoring of specifications in the past has resulted only in confusion and disorganization to contractor and railroad alike until there has been no standard sized tie and no uniformity in inspection. It is to be hoped that the roads will not return to the earlier practices, but that they will retain these specifications, amended where necessary to improve them. One of the objects of the American Railway Engineering Association is the promotion of standard practices among the railways. There is no place where it can serve to better advantage than here.

Larger Opportunities for the A. R. E. A.

One feature of President Stimson's address which was of special interest was the comment on the increase in membership as a consequence of a special campaign undertaken to that specific end. Nearly 200 new names were added to the roster between January 27 and March 10, a period of only six weeks, with the net result that the increase in membership for the last year was the greatest since the first 12 months in the life of the association. This is but a beginning. Commendable as is this record, it represents but a small fraction of the addition that could be made if a thoroughly concerted effort were made with the entire membership behind it.

Some idea of the possibilities may be had from the record of the Western Society of Engineers last fall, when, as the result of a two weeks' intensive drive, 2,000 new members were obtained within a radius of 50 miles of Chicago. This did not imply reduced vigilance on the part of the membership committee in demanding strict compliance with the professional requirements for admission. Likewise, in the case of the A. R. E. A., no lowering of the bars is implied in any of the suggestions which we offer here as to the possibilities for increasing membership.

The first requisite for the success in any membership drive is publicity. To recruit the efforts of all the old members, it is necessary that they be thoroughly alive to the fact that a drive is in progress. Doubtless many of the members present at Tuesday's meeting were entirely unaware that there had been any thought of a campaign for members until they heard the president's address. The publicity should go even further. The prospective members should also be aware of the association's plans. Personal solicitation is made far more simple if the candidate is properly prepared; otherwise the solicitor must himself provide all the momentum to carry the spirit of the drive home to the men he approaches.

In this same connection President Stimson also called attention to a field in which the association can increase its usefulness and which has a direct bearing on the possibility for increased membership. He referred to the recent tendency of engineering graduates to favor lines of engineering outside of the railways as offering greater opportunities and declared it was the duty of the engineering officers of the railways to combat this idea by doing everything within their power to encourage the young men in their organizations.

Membership of the younger men in the A. R. E. A. would afford them opportunity for contact with the leaders in the profession and give them a broader view of the possibilities of railway employment. It will be advisable for the association to offer the younger members encouragement in the way of increased activities in committee work, possibly through the organization of regional divisions of the association. No other phase of the society's activities deserves more serious consideration at this time.

Pay More Attention to Ties

Some eight or nine years ago an epidemic of rail failures was visited upon the roads of this country, the effects of which were so far-reaching and in some cases so severe that railway officers of all ranks were given a shock from which they recovered but slowly. With the object lesson of this disastrous experience, steps were taken to promote an improvement in rail technology in which the American Railway Engineering Association has played a very important part and these efforts have been well repaid by the improved results secured from the subsequent rollings. Commendable as have been the efforts of the railways to obtain better practice as to rail manufacture, and use, it must be remembered that a very sinister incentive has always been present. Defective rails imply more than the expense of premature renewals—the possibility of a rail failure with its sequel of train accidents is an ever present potentiality.

Not so with ties. Except under exceedingly careless maintenance, inadequate life of the ties does not involve danger to train operation. Instead it is purely a case of wasting the stockholders' money. Possibly it is this absence of the element of danger that is responsible for the seeming attitude of indifference assumed by some roads toward the tie problem. The Committee on Ties is alive to this and strongly recommends the collecting of tie renewal data under the auspices of the American Railroad Association in a manner similar to that followed with rail statistics.

A new object lesson is now at hand. The railroads are confronted with a condition that will point to the need of making each tie last just as long as present knowledge of the timber treater will insure. We refer to the great increase in the cost of ties. Perhaps the present prices are not warranted by actual relationships as to the demand and the available supply of tie timber, but if the abnormal quotations serve to spur the roads to a greater regard for the value of a tie, some measure of compensation shall have been realized.

The present need is not so much for further scientific investigations as for the universal application of the knowledge now at hand. The advantages of timber treatment and protection against mechanical destruction are thoroughly established. Why not put them into general use?

Where Do You Stand?

The American Railway Engineering Association was organized primarily to investigate engineering problems, to disseminate engineering knowledge and to increase the efficiency of its members, whose stock in trade in the business world consists essentially of their personal professional service. The railways are now more than ever in need of competent engineers, and they are fast absorbing those who are favorably known and readily available. The younger man meets a slower market. A young engineer who "looks good" and who starts well sometimes falls suddenly behind in the race for preferment. An analysis of the reasons for his failure to progress almost invariably uncovers some negligence of interest in matters outside his routine railway duties. No man can compete successfully with professional men unless he acquires a favorable standing among them. The esteem in which an engineer is held by his professional acquaintances is among the best measures of his true worth.

One of the most valuable assets of membership in the A.R.E.A. to the young engineer is not the speaking acquaintances he may make among its members, but the

recognition he merits from them for the part he takes in engineering work. His active interest as a member of a standing committee of this association, for instance, is a double personal asset drawing compound interest. The value he gets out of it is measured by his unselfish efforts to solve the problems assigned him; but in this faithful performance he builds up for himself unconsciously a character and a place of value in the minds of his fellow engineers. There are degrees of activity in association affairs as in all other matters of life. The man who would receive the most must give most freely.

The association is a powerful and growing factor in railway circles. Its already large membership is steadily increasing and the younger men who become members need scope for their energies and covet places on the standing committees. In order to preserve an even balance of returns from those committees, a thorough system of grading the results obtained from the individual committee members, supplemented by a suitable program of annual rotation of the membership, has been suggested. There are many reasons why some association members are less active than others, but there seems no sufficient reason why one member's activities should be held in leash by reason of other members being allowed to retain passive committee memberships year after year. A person who accepts the office and shirks the work is not worthy of consideration. Until the best possible committeemen have been selected justice will not have been accomplished. The most direct method would seem to be the individual test of committee members by systematic grading during actual trial. In the last analysis the most valuable results are obtained from subcommittees whose memberships are well balanced and whose chairmen are selected first with a view to their ability as organizers.

It lies within the power of the association to insist that all subcommittees measure up to this standard. In justice to the organization and to those who annually contribute their time and their talents to its problems and its ideals, only those members who are earnest in living up to the responsibilities they accept are worthy of the recognition indicated by committee appointments.

Today's Program

The program for the American Railway Engineering Association for the meeting today will be as follows:

Economics of Railway Labor	Bulletin 223
Signals and Interlocking	Bulletin 224
Yards and Terminals	Bulletin 225
Rail	Bulletin 225
Records and Accounts	Bulletin 222
Signs, Fences and Crossings	Bulletin 223
Economics of Railway Operation	Bulletin 225
Special—Standardization	Bulletin 223

New Business.
Election and Installation of Officers.
Adjournment.

Roadmasters' Committee Meets

The executive committee of the Roadmasters' and Maintenance of Way Association met at the Auditorium Hotel yesterday in all-day session to consider a number of problems confronting the association. The movement to transfer the next convention from St. Louis to Chicago was dropped after extended consideration, while P. J. McAndrews, secretary of the association, withdrew his resignation and agreed to serve the remainder of his term. A committee was appointed to consider increasing the dues and the employment of a permanent secretary.

Mr. Hooley on Nurses

"WHAT WAS IT YE SHTARTED t' say about wit noorses f'r th' Injineering Association?" inquired Mr. Dennissey, making his usual evening call upon his friend Hooley, for the lack of any other convenient and congenial companionship.

"'Tis this way," replied Mr. Hooley, settling himself comfortably in the assurance that he would not be interrupted as formerly by frequent calls for service. "Before th' gov'mint tuk over the relrods on account av th' exiggencies av th' war, there was a lot of associations that had grown up in th' different branches av the relrod service. There was th' Emseebees, 'nd th' McHannicks, 'nd th' Signal min, that I've towld ye about before, 'nd a lot av others, besides th' injineers that I've been discoursin' t' ye about f'r the last two av'nins. Thin there was th' big, gin'ral association av executive officers, which ricomminded t' th' relrods whither they should follow th' ricommindations av their subordinate officers or t'row thim in th' waste basket 'nd go on th' same owld way.

"Whin th' gov'mint tuk over th' roads, th' gin'ral association became a part of th' Administhration 'nd thried t' take over arl th' little associations, like a hin carls th' chicks undher her wings whin there is any sign av danger. Th' injineers didn't go, 'nd th' owld hin's been cluckin' f'r thim iver since.

"T' dhrop me parrabul," continued Mr. Hooley, "'nd come down to brass tacks, I'll till ye wan instance. Th' Thrack Comity av th' injineers had a meeting scheduled f'r th' Choosday, it was, in Pittsboorg. Th' gin'ral Association got wind av it, 'nd thot t'wud be good t' get th' shtart av it, 'nd carled a meeting av th' Thrack Comity in Noo York on the Saturday before, f'r th' purpose, I mind me th' words as wan av me frinds towld me, av making immagit raypoort on th' quistion affectin' practices after Federal Conthrol—Shud or shud not th' prisint thrack shtandards be raytained? This mint th' shtandards that had bin adopted be th' Relrod Administhration undher gov'mint conthrol.

"Will 'nd good. Th' Comity mit in Noo York, 'nd raypoorted that 's far 's cud be ascertained th' Relrod Administhration had nayther adopted nor putt into use jurin' Federal Conthrol any shtandards 's ricomminded by th' Thrack Comity, each relrod havin' kipt to its own shtandards 'nd practices. 'Nd there ye are."

"I don't say," murmured Mr. Dennissey blankly, "where th' wit noorse comes in."

"Nayther do I," replied Mr. Hooley, preparing to close up. "She didn't git in. Th' b'y wuz twinty-wan years owld 'nd didn't rayquire her services."

Suffering From Floods

A number of the roads in southern Michigan have been contending with unusual high water and with ice gorges during the last few days incident to the spring break-up. This has served to keep a number of men away from the meetings, while others arrived yesterday after several days' vigil.

F. T. Hatch Dies

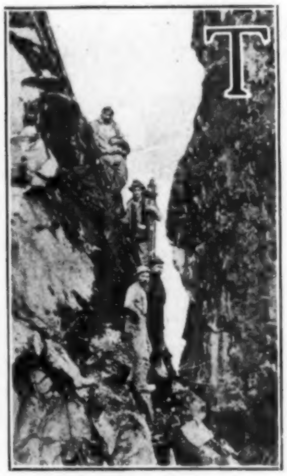
Frederick T. Hatch, consulting engineer in charge of valuation matters on the Pennsylvania Railroad, with headquarters at St. Louis, Mo., and formerly chief engineer maintenance of way of the St. Louis System, died in that city on March 9, at the age of 64 years. Mr. Hatch was a pioneer member of the American Society of Civil Engineers, his membership number being 182.

Railway Engineering Association Proceedings

An Account of Wednesday's Sessions, Including Presentation of Eight Committee Reports with Discussions

THE SECOND DAY'S SESSION of the convention of the American Railway Engineering Association yesterday morning was called to order promptly at 10 o'clock by President Stimson. As was the case during the two sessions on Tuesday, the convention hall filled up very rapidly and held a capacity crowd practically the entire day. Owing to inability to complete the entire program for the first day, the report of the Committee on Economics of Railway Location was held over from the Tuesday session. The report of this committee, which was the first one to be called, and those presented subsequently appear below.

Report on Economics of Railway Location



THE COMMITTEE referred to a monograph on the effect of curvature on the cost of maintenance of way and equipment entitled "A Study of the Mechanics of Curve Resistance," Bulletin 207, July, 1918.* In Appendix A certain matter taken therefrom with conclusions and diagrams were recommended for insertion in the Manual.

In Appendix B of its report the committee submitted the results of its study of the effect of train resistance on amount of fuel consumed in connection with data heretofore submitted and published in the Manual. Monographs on the economics of location—electric locomotives—are given in Appendices C and D.

CONCLUSIONS

1. The committee recommended that the matter given in Appendix A, beginning with the words, "Curve Resistance—Freight Cars," and ending with "Tests did not include engine driving wheels," be adopted and printed in the Manual.

Committee: R. N. Begien (B. & O.), chairman; C. P. Howard (I. C. C.), vice-chairman; F. H. Alfred (P. M.), Willard Beahan (N. Y. C.), E. J. Beugler (West. Church Kerr), W. J. Cunningham (U. S. R. A.), C. F. W. Felt (A. T. & S. F.), R. D. Garner (Sou. N. E.), A. S. Going (G. T.), *A. J. Himes, H. C. Ives (Wor. Ply. Ins.), W. A. James (C. P. R.), Fred Lavis (Cons. Engr.), G. A. Mountain (Can. Ry. Com.), Edward C. Schmidt (U. S. A.), A. K. Shurtleff (Asst. Sec.), C. H. Splitstone (Erie), M. F. Steinberger (B. & O.), L. L. Tallyn (D. L. & W.), R. Trimble (P. L. W.), W. F. Tye (Cons. Engr.), W L. Webb (Cons. Engr.), H. C. Williams (L. & N.), M. A. Zook (I. C. C.).

*Published in abstract in the *Railway Age* of October 11, 1918, page 665.

*Died November 3, 1919.

Recommended for Insertion in the Manual

(To come after matter headed "Curvature," page 538 of the Manual)

CURVE RESISTANCE—FREIGHT CARS

Tests made on the Canadian Pacific at Winnipeg on wheels of freight cars running on curved and straight track demonstrate:

(1) All outer wheels of railway cars exert a pressure against the outer rail when rounding a curve.

(2) The cause of this pressure is the tendency of a cylindrical body to rotate in a straight line at right angles to the axis of rotation.

(3) That there is never any skidding of either wheel of the leading axle of a truck unless it is a forward skidding of both wheels caused by the resistance to rotation being great enough to cause a slight retardation to rotation which results in an apparent forward skidding.

(4) That there is no skidding of the outer wheel of a rear axle, that in general any skidding that does take place is on the inner wheel of the rear axle.

These tests also suggest that as the flange is pressed against the rail, the concave curve at the base of flange increases the effective diameter of the outer wheel so as to prevent skidding of the wheels of front axle and to min-

imize, if not entirely prevent, skidding of either wheel in the rear axle.

Appendix C—Economics of Location as Affected by the Introduction of Electric Locomotives

By E. H. McHenry

In general the governing factors affecting the economics of location of steam-operated railroads are also fundamentally applicable to electrically operated railroads, but are more or less modified by the introduction of some new elements and conditions which are not common to both methods of operation and the study of the subject assigned to this committee will be greatly facilitated by a clear perception of the inherent characteristics of an electric locomotive as distinguished from those of a steam engine.

The effect of the new elements introduced by electric traction upon economic values indicates that the values heretofore assumed under classified heads of Distance, Rise and Fall, Curvature and Rate of Grade will be much affected, but little more than a brief mention of the most salient features can be given here, as follows:

Distance

Train wages, fuel and repairs are the largest single items of expense, which vary most directly with distance, of which the first is but little affected by the change from steam to electric power, but a new and additional charge is created of large amount for the operation and maintenance of power stations and of transmission and distributing systems.

The cost of fuel is most fundamentally affected, as net savings of 50 per cent, 60 per cent and 67 per cent, respectively, may be expected in passenger, freight and switching service. These high percentages in combination with the large amounts expended for fuel are the chief elements in the economy of electric operation and the amount of the reduction in such charges is usually the determining factor.

Engine repairs are also much reduced, perhaps in a ratio of 50 per cent or more of the equivalent charges in steam operation, but the saving is partially offset by the cost of maintenance and repairs of power stations and sub-stations.

Conditions are simplified and expenditures reduced at engine terminals by the elimination of water tanks, coaling stations, ash pits and turn tables and opportunities are often presented for further reductions in the cost of maintaining such facilities by extending the length of engine runs between district terminals; also all intermediate water and fuel stations may often be abandoned.

The cost of track maintenance will, under present conditions, be generally increased not only by the additional charges for the maintenance of overhead or third rail contact and distributing systems, but also by the destructive effect upon rails and fastenings, of the greater impacts, due to the imperfect cushioning of the heavy weights of the electric motors. With electric operation it is both practical and economical to keep within the critical limits by spreading the necessary weights over a greater number of driving axles, with maximum loads preferably not exceeding 50,000 lb. per axle.

Rise and Fall

The unit values of the several minor classifications under this head, will be determined as before with modified factors of cost, but at least two new elements must be considered and included in the final results, viz.: the time and temperature limitations of the electric motor and the possibilities of regeneration of power on descending inclines.

The cost of Rise and Fall will, of course, be reduced if advantage is taken of opportunities for the regeneration of power by trains on descending grades. The value of such regeneration is usually underestimated, but nevertheless is very considerable under proper conditions. Theoretically the amount of power generated in the descent should equal that consumed on the rise, but deductions for rolling friction and the doubled efficiency losses in motors will reduce the available power to a possible maximum approximating 50 per cent. The actual percentage which can be utilized will depend upon the length and steepness of inclines, the total length of the electrified section and the number and distribution of daily trains.

Electric braking (with or without regeneration) in its effect upon the wear of brake shoes and rails, and upon the comparative ease and safety of operation, are also elements entering into the final values to be established.

Curvature

The effect of a change to electric operation as effected by curvature will be in degree rather than in kind, with one possible exception, as the shorter rigid wheel base of some types of electric locomotives will result in reduced resistance and wear of wheels and rails. Such resistance and wear probably varies inversely as the square of the length of rigid wheel base and accordingly even small differences in length may have relatively high economic values.

Rate of Grade

The effects of rate of grade and of rise and fall are more closely inter-related in electric than in steam operation and must be so studied. In general it can be safely stated that the train tonnage ratings in steam service is much more often determined by the average resistance of the division and the boiler horsepower of the engine than by the resistance of the maximum grades, or, in other words, the time schedule rather than the maximum resistance fixes the tonnage rating of each type of engine in service, and when such conditions exist all considerations of maximum grades are merged into that of rise and fall only. If, however, the inherent characteristic of the electric motor permit the development of higher speed and horsepower, within its nominal rating, then the resistance of the maximum grade may become the limiting factor instead of the time schedule and its rate becomes economically important.

In heavy service, and more particularly on mountain inclines, the economic value of electric operation may be quite high, as it is possible to add engine units without adding engine crews, which in combination with their comparative independence of local engine facilities makes this feature peculiarly valuable under conditions requiring assistant engine service.

Appendix D—Economies of Location as Effected by the Introduction of Electric Locomotives

By A. S. Going

(1) Fuel expense both as regards reduced cost of electric power, elimination of coal tonnage and coal facilities required for steam engine.

(2) Reduced cost of engine maintenance, both direct shop expense and engine house expense, which latter is practically eliminated.

(3) Greater capacity as regards speed on heavy grades.

(4) Longer engine districts.

(5) Full tonnage trains can be handled at speeds as high as permitted by the alinement of the road with no restriction due to the profile.

The expediency of electrification may be summed up as desirable from two standpoints.

(1) Increased track tonnage capacity provided by reason of heavier trains, higher speed and reduction in the number of daily train movements.

(2) The cost of electrification in many cases is found to be considerably less than the cost of corresponding improvements with continued steam engine operation, and there is also a return upon the additional capital charge incurred for electrification of from 15 to 20 per cent resulting from the savings in operating expense over steam operation.

One of the many advantages incident to the electric locomotive is the fact that it is possible to use its entire weight for traction purposes and thus effect a saving in the total weight. It is also possible to construct the running gear so that it can operate around curves of very short radius without the use of special guiding trucks not supplied with power.

To make electricity a commercial competitor of steam, it is necessary for two favorable conditions to apply:

(1) Sufficient tonnage.

(2) Available power facilities.

Regarding tonnage, a very approximate minimum limit may be set on roads with heavy grades amounting to 15,000 tons daily in one direction.

Repairs constitute another very important item, these frequently exceeding 20 cents per mile for a steam engine having only about 60 per cent of the tonnage moving capacity of the electric machine and making 35,000 miles per annum under the most favorable conditions.

Regarding opportunities for profitable electrification other than mountain grade installation there should be mentioned the possibilities inherent in low grade freight lines and in large switching yards. Electric yard service should have everything in its favor from an operating standpoint, and should show excellent returns, provided that fixed charges are not made prohibitive by having to equip tracks that are used comparatively seldom. With regard to low grade freight lines, there are equally great benefits to be secured, without encountering the disadvantage of infrequently used tracks. The physical need for electric operation is not so great on level routes, even though the traffic may be heavy and the load factor high.

The great cost of reducing grades emphasize the advantage of electrification of the heavy grades instead of lengthening the line to reduce them. The electric locomotive is particularly adapted to steep grades, especially if part of the energy consumed in climbing the grades can be restored to the line in descending it. The advantages of electrification are greater the steeper the grade, not only on account of the larger possible saving from regeneration, but also because with a given resistance the amount of energy required to climb the grade is less than proportioned to the grade.

The efficiency of regeneration may be taken at 80 per cent at the locomotive, so that after deducting from the tractive effort due to the grade, the tractive effort lost in friction, 80 per cent of the balance will be available for restoring power to the line. The cost of high speed in freight service is principally due to the fact that the steam locomotive can rarely generate sufficient horsepower to utilize its tractive rating at speed higher than 10 or 15 m. p. h. and only attains higher speeds at a sacrifice of train tonnage. In the operation of engine districts of relatively low resistance with local sections of high resistance, the motors will be too heavy and too slow on the level sections; or alternately too light to meet the tractive requirements on the section with heavy grades. Under these conditions the electric motor is at a disadvantage when compared with the steam locomotive which can always develop its full "adhesion rating" at lower speeds and constant horsepower without regard to the time or distance over which the maximum effort is exerted. This disability has already been overcome in some measure by special types of induction and series motors.

The actual cost to the railroad company of the fuel consumed on the steam engines presents an interesting study from the standpoint of electric operation. The cost of hauling company coal from mines to several coaling stations is readily determined, as is also the expense incurred at these stations. What is not so apparent, however, is that this coal retraces its journey this time on the engine tender, and that the annual ton miles movement of company coal in cars and on tender may readily reach 10 per cent of the total gross ton miles carried over the rail.

With regenerative braking, the strain on drawbars and couplings is reduced to a minimum, since the entire train is bunched behind the locomotive, and held to a uniform speed. The electric braking mechanism automatically controls the speed by regulating the amount of energy fed back to the line. Regenerative electric braking adds materially to the safety of operation by supplying a second braking system in addition to the air brakes. It provides increased economy of operation, by reducing wheel, track and brakeshoe wear. It permits faster speeds down grades, due to the better ability of definitely controlling the locomotive, which is difficult at best with air brakes.

Minority Report

In its recommendations for future work, the committee advanced certain opinions on subjects to be investigated.

These subjects are of far-reaching importance and by all means should be considered in assigning future work to the Committee on Economics, but have not yet been fully considered by this committee.

The paragraphs in question are:

"The recent award of time-and-a-half for overtime in slow freight service will undoubtedly call for a revision of operating methods. It has been stated by some that shorter divisions will be the rule; in fact, some railroads are considering the advisability of putting terminals between the present terminals, but trainload will be less of a feature than formerly. It is not unlikely that a careful study will disclose that lengthening the distance between terminals and increasing the speed and providing running tracks and devices for taking water on the run, and perhaps other devices to avoid stopping the train, will prove far more economical than increasing the number of terminals and maintaining the trainload.

"The location of passing tracks will undoubtedly be affected. The value of light grades as compared with heavy grades will decrease, and the electrification of railroads will take on new value.

"Under present operating conditions it is probable that it will become more economical to provide additional running tracks than to revise the grades and decrease the number of trains with the faster movement which will be called for by the new conditions.

"It has been repeatedly demonstrated in railroad operation that it is more valuable to provide facilities for keeping the trains moving than it is to provide low grades and light curvature."

Any change in economic conditions which affects operation will affect the economics of location more or less, but we are not prepared to indorse these opinions to the extent that they magnify the importance of speed and minimize the importance of tonnage and grades. It must be remembered that three years ago it was the emphatic and practically unanimous contention of the railroads that even with an eight-hour day and time and a half for overtime it would be more economical to continue present methods of operation rather than to increase

speed by cutting tonnage, increasing facilities, increasing power or any combination of these expedients.

C. P. Howard (Vice-Chairman).

Discussion

C. P. Howard (vice-chairman) presented the report and continued as follows:

The committee has no recommendation to make at this time as to revision of the Manual. Some recommendations follow for future work which contain some decided expressions of opinion on certain subjects of importance, and a minority report is submitted dissenting from those opinions. They are taken from a review of the subject by Mr. Sullivan, who has conducted some very extensive tests on the Canadian Pacific as to curve resistance on freight car wheels.

The committee has no other conclusions to present, and I move that these conclusions be adopted for insertion in the Manual.

(Motion seconded and carried.)

Fred Lavis (Am. Int. Corp.): I have been firmly convinced for a long time that unless some money is appropriated to carry on the necessary experiments to provide data for this committee, we shall not reach any conclusions on the subject. Many do not think that the economics of railway location is of much importance today, because there is very little money available for new lines, but these questions go beyond this, for they affect improvements on old lines.

(The committee was dismissed with the thanks of the association.)

Report of the Committee on Ties

A REPORT ON THE revision of the manual is given in Appendix A. A report on the effect of the design of tie plates and spikes on the durability of ties is given in Appendix B. Methods for controlling tie renewals are discussed in Appendix C. A report on changes in Forms M. W. 301, 302, 303, 304 is given in Appendix D. The committee also submitted its annual progress report on substitute ties.

The committee was requested to recommend whether the use of A. R. E. A. "Specifications for Cross-Ties" is preferable to that of the United States Railroad Administration "Specification for Cross-Ties," after the period of federal control, and at a meeting of the committee at Buffalo, N. Y., December 5, 1919, the following resolution was adopted:

"Resolved, That under the existing conditions it is recommended by the Committee on Ties that the use of the specifictaion for cross-ties of the United States Railroad Administration, dated June 11, 1918, be continued."

Conclusions

The committee recommended:

Approval of the revision of the Manual.

That subjects 2, 3 and 6 be received as progress reports and as information.

That Form "A," shown in Appendix D, be approved and that Forms 301, 302, 303 and 304 be withdrawn from the Manual.

Committee: F. R. Layng (B. & L. E.), chairman; H. S. Wilgus, vice-chairman; W. C. Baisinger (A. T. & S. F.), F. T. Beckett (C. R. I. & P.), M. S. Blaiklock, F. Boardman (N. Y. C.), W. J. Burton (M. P.), W. A. Clark (D. & I. R.), S. B. Clement (T. & N. O.), E. L. Crugar (I. C.), L. A. Downs (C. of Ga.), G. F. Hand (N. Y. N. H. & H.), A. J. Neafie (D. & L. W.), G. P. Palmer (B. & O. C. T.), L. J. Riegler (P. L. W.), Louis Yager (N. P.).

Appendix A—(1) Revision of Manual

Conservation of Timber Supply for Railroad Ties

(3) *Present Form*—Tie specifications should be rigidly enforced with particular reference to the exclusion of small ties.

Proposed Form—Omit.

(4) *Present Form*—There should be co-operation among the railways in any given territory with a view to the adoption of standard tie specifications, with particular reference to making it impossible for contractors to furnish ties cut from small trees which would naturally form sources for future tie supplies.

Proposed Form—Tie specifications should be so drawn and enforced that only such small ties as result from conservative methods of lumbering would be accepted, thus discouraging the cutting of small trees.

(9) (*Additional paragraph*)—Experiments with substitute ties should be encouraged.

Appendix B—Effect of Design of Tie Plates and Spikes on Durability of Ties

The committee endeavored to study especially the effect of the screw spike on the durability of the tie and investigated some 230 mi. of screw spike installation, stopping at frequent intervals to make detail inspections of the ties and fastenings. They have found varying conditions of installations and results. Some screw spike installations, made in 1908 in good treated ties, were found to be still in thoroughly good condition and capable of many more years' life. Some other installations, made at various times since, have not been so effective. The defects found which seem to the committee to cause over-strain of the wooden threads of the tie which holds the screw spike may be described as follows:

Improper Design of Fastenings

The threads in the wood were found injured where the screw spike did not have an accurate and uniform pitch and diameter of core. Where that condition existed the first installation of the spike injured a portion of the fiber, and where the screw spike had been changed, in connection with replacing a rail or tie plate, further damage was done. The wood fibers at the top of the hole in the tie were found destroyed where the screw spike used had no pilot or small point on the end to permit its being screwed into place after being set in with a light tap of the hammer.

Improper Kind of Wood in Ties

Some soft wood ties were found which were not strong enough to hold the thread under the stress produced by the heavy traffic and axle loads carried.

Improper Method of Installation

The most common cause of destruction of the threads in the tie was found to be due to the screw spike having been partly driven with a hammer in starting.

Decay was found in ties where spike holes were bored after the tie was treated and no preservative put in the holes before applying the spike. Where the hole in the

tie had not been bored deep enough to permit setting spikes down as the tie plate embeds itself, the wood threads were stripped in an attempt to tighten the spike.

Standard of Maintenance

The condition of line, surface and the stability of the roadbed were found to have an important effect on the holding power of the spike, the over-straining apparently beginning when there was more movement of the rail on the tie than freeway space could be allowed for.

From the varying methods and results seen, the committee stated the conditions it believes necessary for the protection of the tie in connection with a screw spike installation:

(1) The timber of the tie should be adequate in strength for the tonnage and maximum axle loads carried.

(2) The ties should be bored and adzed, and where the timber used is to be treated, that treatment should be applied after the boring and adzing is done.

(3) The holes for the screw spikes should be bored completely through the ties, except that special consideration should be given this question where there is a heavy electric current in the track rail which might become grounded by this means. These holes should have the same diameter as the shank of the screw spike.

(4) A shoulder tie plate should be used of proper design, correct dimensions, width, length and thickness, to properly protect the tie, so designed that the spike does not in itself maintain gage, but holds the plate securely to the tie, thereby enabling the shoulder to maintain a proper track gage without a spike-rail base contact, reducing to a minimum spike cutting and mechanical tie destruction.

(5) When the screw spikes are placed in slots of the angle bars care must be taken to see there is not an undue stress on the screw spikes from creeping rail. The rail should be anchored so as to prevent its running on the ties, to permit the full use and value of the screw spike when the spikes are placed in the slots of the angle bars.

(6) The screw spike should have an exactly uniform pitch and size of core. The diameter of the lower part of the screw spike should be decreased so that the beginning of the thread is slightly less than the diameter of the hole bored in the tie. It is considered essential that the spike be screwed in the wood without the fiber of the wood being destroyed. In order to accomplish this, the spike must be started with a very light tap—just sufficient to get holding power in the threads to permit its being turned in the tie. For this purpose the use of the screw spike adopted by this Association is considered essential. The present injurious practice of starting by driving the spike should be discontinued.

The following is suggested as good practice to get economic results:

(1) At least four holes should be bored in each plate bearing area even if only two screw spikes are used at each rail. This is an advantage in helping quick repair in case of damage to track. It would also have some effect in treatment by allowing the preservative to get where it is of the greatest value.

(2) The materials used for connecting the rail to the tie should be of such character and strength as to equal the expected life of the tie. The renewal or changing of these fastenings has a tendency to weaken the tie, and the cost of making these renewals should justify a reasonable expense to make these materials of full strength and to protect them against corrosion.

(3) It is believed that the full benefit of a screw spike installation cannot be obtained unless the standard of maintenance of line and surface is fairly high as compared with the tonnage and character of traffic passing over the track; that the roadbed should have good drainage, well tamped track, fair line and surface, and a foundation which is not too yielding.

Conclusion

It is the opinion of the committee that screw spike installations should be made in conformity with the above recommended practice in order to properly protect the tie. It is difficult to measure accurately the damage done to a tie by a screw spike until some of the modern installations have been in longer, so that a definite and economic statement can be made from the records. Each year adds to the information available, but it is probable that conclusive figures will not be made until the life of the present modern installations can be determined.

Appendix C—Report on Best Methods in Use for Controlling Tie Renewals

A questionnaire was submitted to the members of the association for the purpose of obtaining the personal opinion of the members, regardless of the existing practice. Replies were received from 92 railroads with an aggregate mileage of 149,552. It was evident from the replies that in most cases the recommendations were probably based on a personal opinion corresponding to the existing practice of the member. A summary of the replies is given below:

	Mileage of Roads
Advocating field inspection by section foremen or others directly responsible	138,169
Against this method	10,591
In favor of method, provided foremen are accompanied by inspectors or superiors	23,301
Advocating field inspection by independent tie inspectors	11,512
Against this method	93,042
In favor of method, provided inspector is accompanied by section foreman	23,674
In favor of method as a check of the other method only	24,492
Advocating use of statistics as a check on other methods	91,263
Against the use of statistics	39,552
Advocating the spotting of ties	99,291
Against the spotting of ties	8,576
Recording ties spotted by miles	36,751
Recording ties spotted by sections	19,177
Recording ties spotted by sub-divisions	8,319

The committee desires to point out that the method in most general use is not necessarily the best. It would seem that there are two general methods which should necessarily be given consideration:

(1) Yearly field inspection by section foremen or their immediate superiors, or others directly in charge of and responsible for the safety of the track.

(2) Yearly field inspection by special inspectors chosen for their experience and knowledge of the requirements of their territory and not generally connected with or responsible for the track or territory inspected.

The use of the first method has a tendency to provide adequate renewals, thereby assuring safety within the limits of available resources. It also provides a basic knowledge of local conditions which no other method can cover. However, there will be undoubtedly a lack of uniformity under similar conditions on various territories, with the possibility of excessive and uneconomical renewals.

The second method provides for training a smaller number of selected men more uniformly to a predetermined system standard of tie renewals than is possible otherwise, and tends to a greater uniformity of practice and consequent conservation of ties. It does, however, present difficulties, such as possible inadequate renewals

at certain points, inability to obtain sufficient proper talent, and finding employment for them outside of the renewal season.

Whatever method is used, the spotting of each tie is considered advisable. The section foremen, however, to be allowed a limited latitude for removing such ties (at variance with the spotting done) which are broken or damaged or otherwise injured so as to destroy their usefulness.

The use of statistics for approximate determination of tie requirements in advance of field inspection will be found desirable, and where the ties available are less than the final inspection requirements indicate, then the supply should be prorated, making due allowance for local conditions of traffic, curvature, grade and roadbed.

CONCLUSION

The committee considers that the following two methods, when properly organized and supervised, using competent men, will each bring about safe and economical control of tie renewals:

(1) Yearly field inspection by section foremen or their immediate superiors, or others directly in charge of and responsible for the safety of the track.

(2) Yearly field inspection by special inspectors chosen for their experience and knowledge of the requirements of their territory and not generally connected with or responsible for the track or territory inspected.

Appendix D—Changes in Forms M. W. 301, 302, 303, 304

A canvass made by the Tie committee in 1917-18 proved that the forms in the Manual were not in use by any road. Sentiment at the 1919 convention, however, was opposed to elimination of these forms without something in their place. A questionnaire was therefore prepared and sent to all the principal railroads. Replies were received from 58 roads, representing a mileage of 156,510.

These replies were tabulated and a summary indicates:

(a) 39 roads with a mileage of 87,460 keep no detailed data on life of ties.
(b) 5 roads with a mileage of 12,878 keep data on life of all ties in track.
(c) 21 roads with a mileage of 88,861 keep tie data by use of test sections.
(d) 24 roads with a mileage of 92,292 prefer method of test sections.
(e) 5 roads with a mileage of 12,526 prefer method of keeping data on life of all ties.
(f) 9 roads with a mileage of 27,556 consider information called for on forms 301, 302, 303 and 304 sufficiently valuable to justify its collection.
(g) 32 roads with a mileage of 108,080 do not consider this information sufficiently valuable or reliable to justify use of the forms.
(h) 20 roads with a mileage of 84,352 test section has superseded use of dating nail.
(i) 5 roads with a mileage of 8,388 test section has not superseded use of dating nail.
(j) 18 roads with a mileage of 80,858 use dating nail on test sections.
(k) 13 roads with a mileage of 24,569 do not use dating nail on test sections.
(l) 12 roads with a mileage of 26,352 recommend discontinuance of use of dating nail.
(m) 12 roads with a mileage of 54,101 recommend discontinuance of use of dating nail except on test sections.
(n) 14 roads with a mileage of 42,833 do not recommend discontinuance of use of dating nail.

The great majority of replies favor the method of test sections for securing data on the life of ties. The American Wood Preservers' Association in 1914 went on record as favoring the test section method. This committee is in hearty accord with that conclusion and feels justified in recommending to the association that the test section method be endorsed as giving more accurate and reliable data on the life of ties in track than can be obtained by attempting to keep a record of the life of all ties.

A few roads report satisfactory results from the method of keeping data on the life of all ties, but the replies indicate and the committee believes that in the majority of cases the test section method is preferable. That conclusion is based on test sections that are carefully arranged for and properly inspected, and the committee recommends study of the methods that are essential to the successful use of the test section as a part of next year's work. The development of forms for use with the test sections should be a part of that assignment and cannot well be done in advance of it.

The committee believes that forms M. W. 301, 302, 303 and 304 call for a large amount of information that it is not practicable for most roads to assemble, and that it is not advisable to retain them in the Manual considering the small number of roads that are in a position to use them and that even they have not done so.

The committee is strongly of the opinion that this association should be collecting such data as is available and it recommends the adoption of Form "A." Most of the information called for by this form is already required by the Interstate Commerce Commission and it is believed the form could be sent out annually by the American Railroad Association.

Form A

A. B. & C. R. R.

Summary of Ties Used in Renewals During the Year 19—.

Mileage ....
Main Tracks ....
Side Tracks ....
Total...............

Kind of Wood	Treated or Untreated	Main Tracks	Side Tracks	Total Track	
....	....	....	....	....	....
....	....	....	....	....	....
....	....	....	....	....	....

Discussion

(F. R. Layng, the chairman, presented the report and moved the adoption of the recommended changes in the Manual. Being sustained in this, he read the conclusions on the effect of design of tie plates and spikes on durability of ties and moved their acceptance as information. His motion was carried. He also read the conclusions on the best methods in use for controlling tie renewals and his motion to receive this as information was carried. He also moved that Form A proposed for the collection of tie statistics be adopted and that the member roads be asked to compile the necessary information. After some discussion of this motion it was carried. Chairman Layng also submitted the report on substitute ties as information and it was accepted by the convention.)

The Chairman: This committee was given a special assignment by the A. R. A., asking whether it would be preferable that the United States Railroad Administration specification for ties be continued after the period of federal control. At a meeting in Buffalo the committee passed the resolutions appearing in the report.

The committee feels that it is desirable that these specifications be continued probably until such time as this committee can submit a new set of specifications, which will probably be prepared this year. I move the association approve the committee's action.

(Motion seconded.)

W. H. Courtenay (L. & N.): Those who have had to deal with tie production during the last two years are thoroughly aware that all of the large tie producers are

bitterly opposed to the government specification. Before the government specification was written, I personally used all of my influence to have it written otherwise. I knew it was not going to be satisfactory to the producers, and it has not been satisfactory to them. I am constrained to say that the Louisville & Nashville will not adopt that classification. It has already made its own specification, which follows the government specification in a way, but not literally. The specification that we have adopted will, I think, enable us to get more ties than we could get under the government specification, yet equally good in quality, though at a less average price. I have not yet seen a practical man engaged in getting out cross-ties who has thoroughly approved of that specification. In a meeting held in Atlanta for the purpose of formulating the specification, there was not a member of the southeastern lines that approved this specification. The chairman of the Regional purchasing committee in the southeastern district went to Washington and exercised his greatest influence in trying to get this specification changed, and he was unable to do so. Some of the roads have not been enforcing it, and there has been a great deal of difference in the way the specification has been construed by different roads.

As a matter of fact, the L. & N. has rejected ties because they did not conform to the specification, and then some of its competitive roads have accepted the rejections, so that I for one do not endorse the specification, although I do not intend to oppose it, for I think it is a matter for each individual road to make its own cross-tie specification.

Dr. von Schrenk: It must be recognized that the outstanding factor in the government specification is the fact that we have found a recognition of ties of different dimensions as to thickness and width. If you look at the specification in the Manual you will find that it is almost impossible to distinguish it in principle from the specification that we have had in the past two years. I do not care what any railroad in this country does in the way of adopting this specification or any other. I want to tell you one thing, that the character of ties depends on whether they are plentiful or scarce. I think the association cannot afford to vote other than in favor of this report.

That disparity in value that we have been accustomed to in this country has gone by for all times. The tendency to buy ties on lineal measurement is that you will pay for what you can get. This question must be considered from the standpoint of the interest of the road buying the ties.

Hunter McDonald (N. C. & St. L.): Speaking of a section that has been the tie producing region for many years, I want to state that this is a question of a new specification. As Mr. Courtenay pointed out, it is a question of inspection, no matter what the specifications are for buying the ties. If we all pledge ourselves here to support this specification, and go away with a mental reservation that we are going to cut the inspections, we might as well keep quiet.

F. H. Alfred (P. M.): If you are going to adhere to this resolution, then it seems to me you must fix the price as Dr. von Schrenk says—if a man goes to a grocer for 10 lb. of sugar, he should not accept 9 lb. and pay for 10 lb. That is true, of course, but if he can get along with 9 lb. there is no reason why he should not take 9 lb. and pay for 9 lb. There are many places where we can use a smaller tie than the standard tie on side lines, and there is no reason why those ties should not be used.

It seems to me that we should not go on record beyond saying that it is our desire to follow as nearly as possible this resolution, or the administration specifications. I am sure that many of us will, if we have not already done it, break away from these specifications if we cannot get what we want under the specifications.

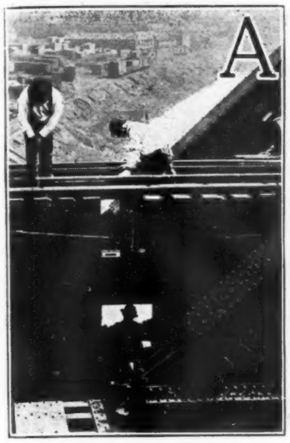
John Foley (P. R. R.): The discussion that has proceeded so far is very similar to the discussion that has gone on for the past two years. Practically none of it is relative to the specification for cross ties whatsoever. The specification, as such, is not responsible for the kind of ties anybody got. The specification is designed simply as a method of grading cross ties, and cross ties were in the past made in a certain way and will probably continue to be made the same way hereafter. The fact that the railroads did not receive as many cross ties as their estimates called for was not influenced in any way, in my judgment, by the specifications. The specification which has been promulgated during the past two years is based strictly on the A. R. E. A. specification and does not differ from it in any essential manner, except in putting the ties with rounded sides in the same class with ties of rectangular form. The specification was designed as an engineering matter entirely. It does not seem to me that the A. R. E. A. when drafting its specifications has to concern itself with price when establishing a standard. There are trees in the United States that will produce whatever size ties the railroads may have need for. When 10,000 ties are produced, that lot will yield a certain amount of money, no matter what price is paid for ties of different grades.

The allegation the contractors are upholding the administration specification is a statement that is not altogether in accordance with the fact. The contractors will supply any kind of ties the railroads desire. All that the specification did was to grade the ties in breaks of 1 in. in width and 1 in. in thickness. If a railroad wished a tie smaller than those provided in the grading, all they had to do was to ask for them. In the case of railroads that felt they could accept ties smaller than those specified, there has been no objection from the U. S. R. A. to permit such ties to be used under certain conditions, and the only difference was they are expected to call them ties other than Grade 1. The great variety in the specifications issued by the railroads in the past, with practically non-adherence to the A. R. E. A. specification has caused a great deal of trouble in the cross tie industry. It was that lack of uniformity which disturbed the industry that justified the attempt of the association to have a standard specification, and certainly the first effort of the U. S. R. A. to have one, and the endeavor to enforce it.

It seems this committee has done the right thing to get the engineers to insist that a tie shall be of a given grade, no matter where you may find it, and if there is any competition involved in the getting of the tie, let them fight it out on the price basis. If you do not want grades 4 and 5, do not ask for them; if grades 1, 2 and 3 are too small for you, do not buy them. Now, it will be possible for everybody to keep in his mind there is only one subject under discussion, and that is the standardization of sizes for cross ties, so that the engineers who desire cross ties will get what they want, and when they get it, they will know what it is, and whether it is called 1, or 6, or 90, makes absolutely no difference. Whether you lump three or four grades in your provision makes no difference. It is all settled in the matter of price, and from contact with the cross tie industry, I think I can speak in the name of the contractors also that the industry will be very much stabilized, production increased, the quality of ties improved, and the whole situation bettered, if the competition that there must be among the railroads was confined exclusively to price.

(Mr. Layng's motion was put to vote and carried, and the committee was excused with the thanks of the association.)

Report on Iron and Steel Structures



APPENDIX A of the committee's report contained revised specifications for steel railway bridges. These specifications are designed to supersede those now in the Manual and a preliminary draft of them was submitted to the association in 1919, being published in part in the *Railway Age* of March 21, page 805. As a consequence of oral discussion at the last convention and written discussion received by the committee subsequently, these specifications have been subject to considerable revision and the specifications as presented in Appendix A represented the results of these revisions. The form of the specifications is substantially the same as given last year.

As the result of a letter addressed to the American Society of Civil Engineers by Chas. E. Fowler, J. E. Grenier and Geo. H. Pegram, the committee was instructed to appoint a sub-committee for conference with a committee from the American Society of Civil Engineers to study all the column data available for the purpose of developing a column formula. At a joint meeting in October a column formula was adopted and the committees composing the conference agreed to recommend it for adoption by their respective societies. The formula also is incorporated in the specifications. Appendix B contains the report of the sub-committee on the work done.

Appendix C contains a report of the sub-committee on ballasted floor bridges and waterproofing and principles for detailed design of flashing, drainage, reinforcement and protection for waterproofing purposes, which was printed as information.

Appendix D contains reasons supporting the adoption of the form of live loading recommended in the specifications.

Conclusions

1. The committee recommended that the Specifications for Steel Railway Bridges be approved and substituted for the specifications in the Manual, pages 482 to 505, inclusive.

2. The committee recommended that the following column formula be approved and published in the Manual:

Column formula for use with ordinary structural steel for which the basic unit tensile stress is 16,000, and for ratios of $\frac{l}{r}$ not greater than 200:

$$p = 15000 - 50\frac{l}{r}, \text{ but not to exceed } 12500.$$

Committee: O. E. Selby (C. C. C. & St. L.), chairman; F. E. Turneaure, vice-chairman; F. Auryansen (L. I.), J. A. Bohland (G. N.), W. S. Bouton (B. & O.), A. W. Carpenter (N. Y. C.), J. E. Crawford (N. & W.), F. O. Dufour (Stone & Webster), W. R. Edwards (I. C. C.), R. L. Huntley (U. P.), A. C. Irwin (Port. Cem. Assoc.), B. R. Leffler (N. Y. C.), W. H. Moore (N. Y. N. H. & H.), P. B. Motley (C. P. R.), C. D. Purdon (St. L. S. W.), Albert Reichmann (Am. Brg. Co.), A. F. Robinson (A. T. & S. F.), H. N. Rodenbaugh (U. S. R. A.), C. E. Smith (Cons. Engr.), I. F. Stern (Cons. Engr.), H. B. Stuart (G. T.), G. E. Tebbetts (York River Shipbldg. Corp.), J. A. L. Waddell (Cons. Engr.), H. T. Welty (N. Y. C.).

Appendix B—Column Formulas

In the revised specifications presented last year (1919) by the committee the column formula proposed was of the parabolic form, namely, $p = 13000 - \frac{1}{4}\left(\frac{r}{l}\right)^2$. Inasmuch as the proposed revision was published only a short time prior to the annual meeting, and in consideration of various criticisms and suggestions the whole matter was referred back to the committee for further study. In proceeding with this work the question of column formula was assigned to a sub-committee. This sub-committee has restudied the whole matter and at the request of the main committee presented a report of its study and conclusions.

The proposed parabolic formula above mentioned was based on a careful analysis of all available data, and is still believed to be the most consistent single formula for ordinary ratios of l/r, but in the interest of simplicity and to provide a formula applicable to higher values of l/r, a straight line formula with maximum limits has been substituted in the report of the present year. It will be found that this proposed formula differs but little from the parabolic formula for values of l/r below 150, but that it has the advantage of being applicable for much higher values of l/r, a matter of considerable importance in dealing with old structures and in designing various types of construction encountered in the practice of bridge departments.

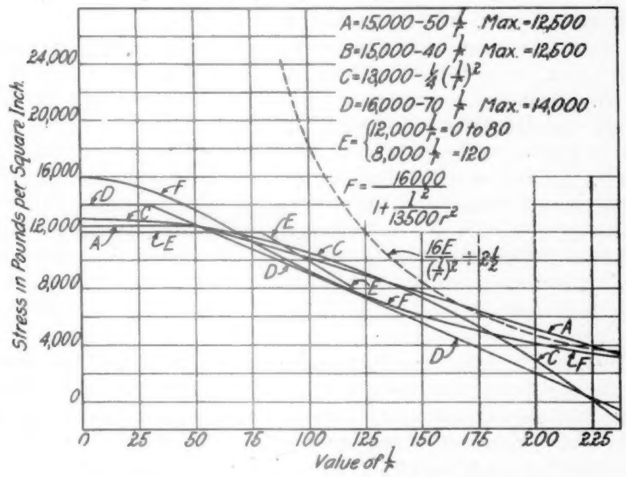


Fig. 1—A Comparison of Column Formulas

The proposed formula is $p = 15000 - 50$ l/r; maximum value 12500. It is applicable for values of l/r up to 250. Limiting values of l/r for bridge design are given elsewhere in the specifications.

The data upon which the conclusions have been based cover all the available data of tests of pin and flat ended built-up columns and columns composed of single shapes of larger than about four square inches in cross-section. A number of tests were not included owing to the fact that pins were eccentric or to failure in end details. Tests of the A. R. E. A. series where tie plates were used were not included, as these columns failed at values much below those having proper lacing. Several tests of large columns reported in Bulletin No. 101 of the U. S. Bureau of Standards were not included as these were all rela-

tively short and all failed at about the yield point of the material or in end details.

Appendix C—Principles for the Detailed Design of Flashing, Drainage, Reinforcement and Protection for Waterproofing Purposes

General

1. The following applies only to membrane waterproofing, as the "integral method" is not recommended for waterproofing railroad bridge floors.
2. The structure should be designed so that it can be waterproofed and it should be adaptable to waterproofing by ordinary methods.
3. Strength and stiffness are desirable features in a structure which is to be waterproofed.
4. The structure and its construction and expansion joints, drainage and waterproofing, should be designed together, considering their separate and combined functions, so that each will help to secure a waterproof structure.
5. Due regard should be had for the available methods and materials of construction. Traffic conditions, climate and prevailing markets or supplies, might thus control the design. Wherever possible, waterproofing under traffic should be avoided.
6. All waterproofed surfaces should be easily accessible, and as simple and smooth as possible; hence features should be avoided which would increase the difficulty of securing waterproof construction, such as open spaces, joints, holes, seams or projections.
7. Concrete bridge floors should be of ample strength and thickness and of dense non-porous construction.
8. Where contraflexure would injure the waterproofing, special details should be provided, such as elastic joints.
9. Minimize the number of construction joints in the structure, provided an ample number of workable expansion joints can be introduced. Concrete bridge floors should, where practicable, be built in one continuous operation for each track.

Drainage

10. Adequate drainage should be provided by means of suitable grades which will shed water by the easiest or most direct route. One per cent is a minimum desirable grade, but the grades away from points which are difficult to waterproof, should be correspondingly increased.
11. Avoid pockets which cannot be easily drained. Water with only a slight head may find an outlet through the waterproofing, which otherwise might be tight. Standing water is undesirable on a waterproofed bridge floor, from its destructive effect both as a solvent and also on account of frost action.
12. Where gutters or pipes are necessary, they should be of durable material, of ample size, easy of access to install and maintain, and protected against clogging or damage. The grades should be enough to secure quick and entire escape of the water. Corrugated metal pipes are satisfactory where exposed to alternate freezing and thawing. Where sudden considerable variations in temperature occur, it is not desirable to encase drain pipes in concrete. Cleanouts and manholes should be provided where pipes cannot otherwise be cleaned.
13. Provide free exits for the harmless escape of drainage. Such drainage should not be allowed to disfigure the structure nor to injure persons or property. Icicles may be prevented by a basket of rock salt inserted in the top of the drain pipe.
14. Avoid features which would induce or permit capillary action. For example, where the waterproofing extends up under the top flange, or beneath a flashing angle, it is very desirable to make the water drip off the edge, rather than to allow it to follow the under surface and be drawn into the crack.
15. Where possible, locate edges and joints above the highest probable water level.

Reinforcement

16. Reinforcement of the structure should be suitably disposed, and ample in strength to prevent cracks or distortion which would injure the waterproofing.
17. Cloths, felts or fibers should be capable of holding the waterproofing pitch where placed and should be durable, strong and flexible.
18. Wire mesh or sheet metal reinforcement for the membrane should be of durable material, flexible where necessary, and intimately bonded or introduced so that the waterproofing and reinforcement act together.
19. Necessary breaks in the surface of waterproofing or flashing, such as for drain pipes, should be reinforced with extra flashing material.

Flashing

20. Flashing should be of durable material, sufficiently elastic and strong for the particular duty to be performed, and effective in the position where used.
21. Flashing should be of material which can be readily applied, and should retain the position in which it is placed when subjected to actual conditions of service and temperature.
22. Flashing should be firmly attached in its proper position, so that it cannot be easily displaced or removed.
23. The edges of waterproofing and flashing should be protected against drip, percolation and capillary action.

Protection

24. Waterproofing and flashing should be protected against mechanical injury, excessive temperature, chemical action, or the deterioration caused by exposure to light and air.
25. The protecting covering should be dense, hard, durable and easy to apply.

It is recommended to use on flat surfaces either: (a) Brick laid in cement mortar or served with hot pitch, (b) plain or reinforced cement mortar, (c) plain or reinforced concrete, (d) bituminous mastic.

For surfaces with considerable slope, mastic is not satisfactory, being difficult to apply and also to retain in place.

Appendix D—Specification Loading for the Design of Steel Railroad Bridges

Discussion of the revision of Specifications for Steel Railway Bridges, presented by the committee at the convention in March, 1919, developed differences of opinion regarding the advisability of continuing to design our structures for Cooper's E series of loading, which the committee recommended.

The objections to this type of loading were based on the assumption that, as the Copper engine does not conform very closely to the more modern types of locomotives, such as the Santa Fe or Mallet types, the stresses produced by the Cooper's loading do not reasonably correspond to the stresses produced by engines in actual operation, and the following loadings were suggested as substitutes for the Cooper's E series:

(1) A uniform load.

(2) A uniform load with a series of axle concentrations.

(3) A typical locomotive, more nearly representing modern locomotive construction, both as to axle concentrations and wheel spacing.

Any specification loading must necessarily be based not

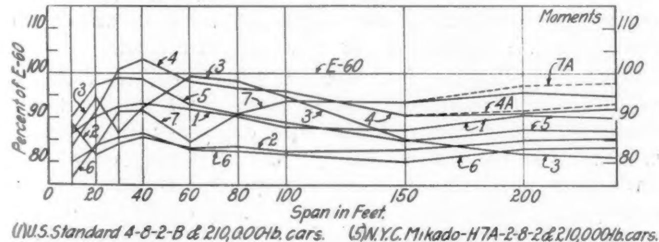
only on loadings which are in actual operation, but should likewise reflect and provide for future development of locomotive and car design. That is, if it is to be reasonably expected that the future development in locomotive design will increase the loading per foot on long spans more rapidly than on short spans, the specification loading should provide for such development.

A system of uniform loading must be determined from some assumed system of wheel loads or from wheel loads actually in operation, and should be so established as to provide for some future increase in loading.

As the effect of the concentrated loads, due to the axle concentration of engines in operation, is, on short spans, radically different from the effects of a uniform load which would correspond to the equivalent uniform load for the longer spans, no system of uniform loading without concentration would give the same results on short spans for moments and shears as that produced by actual loadings now in use, and it, therefore, becomes necessary to consider a uniform load with a series of axle concentrations, in order to provide proper stresses for the shorter spans.

No system of uniform loading with concentrations has been found which will more nearly correspond either with the actual loadings now in operation or with the actual loadings now in operation plus a reasonable future development in locomotive and car design. Furthermore, the adoption of a loading of this kind would involve the use of previously determined tables of moments and shears, such as have been established for the Cooper's E series of loadings, and would not result in any economy of effort in determining stresses in bridge structures.

There appears, therefore, to be no logical reason for the abandonment of the Cooper type of loading for a system of uniform loads or uniform loads plus concentrations, as the change would offer no advantages, but would be the source of a great many positive disadvantages. The question involved, therefore, is the adoption of a specification loading, either Cooper's E series or some other sys-



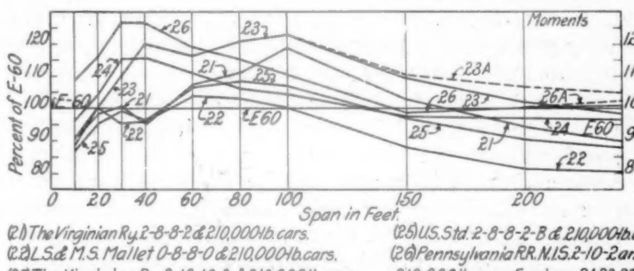
(1) U.S. Standard 4-8-2-B & 210,000-lb. cars.
(2) U.S. Standard 4-6-2-B & " " "
(3) U.S. Standard 2-6-6-2-B & " " "
(4) U.S. Standard 2-10-2-B & " " "
(4A) U.S. Standard 2-10-2-B & 6000-lb. per lin. ft.
(7A) Santa Fe' Type 2-10-2 & 6000-lb. per lin. ft.
(5) N.Y.C. Mikado-H7A-2-8-2 & 210,000-lb. cars.
(6) U.S. Std. 2-8-2 & 210,000 lb. cars.
(7) Santa Fe' Type 2-10-2 & 210,000-lb. cars.
Engines 1, 2, 4, 4A, 5, 6, 7, & 7A double-headed; Engine 3, single-headed.

Fig. 2—Moment Curves (Per Cents of E-60 Loading) for Seven Heavy Road Locomotives

tem of typical engine and car loading, which produces stresses reasonably proportionate to engine and car loadings actually in service, plus future developments of such loadings.

The effects of various types of locomotives on spans from 10 to 300 ft. in length have been considered, and are shown in two groups. Fig. 2 and Fig. 3 show the moment curves for seven heavy road locomotives of various types and six locomotives, representing the heaviest of the various types of engines now generally used in special service.

By reference to Fig. 3 covering the heavy locomotives, it will be noted that the Santa Fe type of engine has the greatest effect, when compared with Cooper's E-60 loading, on spans up to approximately 60 ft. in length, and that the Mallet type has the greatect effect on spans from about 60 to 150 ft. in length. In other words, these two types of locomotives do not similarly affect all spans, and, if a specification loading of the Santa Fe type were adopted, it would not increase the stresses in bridge structures for spans from 60 to 150 ft. in which stresses are highest for the Mallet type of locomotive. Similarly, if the Mallet type of engine were adopted as the specification loading, while it would take care of spans from 60 to 150 ft.,



(21) The Virginian Ry. 2-8-8-2 & 210,000-lb. cars.
(22) L.S. & M.S. Mallet 0-8-8-0 & 210,000-lb. cars.
(23) The Virginian Ry. 2-10-10-2 & 210,000-lb. cars.
(24) Erie Engine 2-10-2 & 210,000 lb. cars.
(23A) The Virginian Ry. 2-10-10-2 & 6000-lb. per lin. ft.
(26A) Pennsylvania N1S. 2-10-2 & 6000-lb. per lin. ft.
(25) U.S. Std. 2-8-8-2-B & 210,000-lb. cars
(26) Pennsylvania R.R. N1S. 2-10-2 and 210,000 lb. cars. Engines 21, 22, 23, 23A & 25, single-headed; engines 24 & 26, 26A, double-headed

Fig. 3—Moment Curves (Per Cents of E-60 Loading) for Heaviest Locomotives

it would produce lighter structures than the Santa Fe type for spans shorter than 60 ft.

The substance of the foregoing is that, to produce stresses corresponding to both the Santa Fe and the Mallet types of engine for spans from 10 to 150 ft., a combination of the two engines would be required. This is accomplished by the use of the Cooper's E series of loadings. It will be noted that the peaks of the curves for the Santa Fe and Mallet types of heavy locomotives practically correspond to a line equivalent to Cooper's E-75 loading.

The effect of the engines now in operation, on the short span lengths, is greater when compared with the Cooper's E-60 loading than on longer span lengths, and this is as it should be, for the following reasons:

(1) Bridges with span lengths from 10 to 100 ft. are of the plate girder type, which is the best type of bridge to have from a maintenance standpoint. Such bridges may be more highly stressed than bridges of the truss type.

(2) Future developments in engine and car loading will increase the loading on the longer spans more rapidly than on the shorter spans, due to the lengthening out of the engine and the increasing of the car loads. With this development, the engine curves, if plotted in percentages of Cooper's series, would more nearly approach the 100 per cent line for spans in excess of 100 ft. This is shown by the dotted lines on Figs. 2 and 3 showing the effects of a car loading of 6,000 lb. per ft.

In addition to the foregoing, the fact should not be overlooked that the Cooper's E series of loadings has been in use for a great many years, and generally adopted by most roads, not only for the design of new structures, but in the re-calculation of old structures. Engines in operation have been rated in terms of Cooper's E loading and bridges have been similarly rated. Operating officers have become conversant with what the Cooper's loadings mean, and a change from the Cooper system should not be made, unless the Cooper series of loadings is inadequate.

In the light of the foregoing it has been concluded that

the Cooper's E series of loadings are the most practicable loadings for the design of railroad bridges.

Discussion

O. E. Selby (chairman) presented the report and continued as follows: On behalf of the committee I move the adoption of conclusion 2 of the report relating to columns.

(Motion seconded and carried.)

Mr. Selby: The committee considers it of the greatest importance to the association that the specifications in Appendix A be acted upon at this convention. They have been referred back once, and they should not be subjected to that treatment again, for the reason that there is a very great demand for the specifications in their revised form in this country and abroad.

C. W. Baldridge (A. T. & S. F.): As Article 3, "Drawings to Govern," is now written, it provides that the specifications are always wrong, and the drawings are always right, which may not be the case, and inasmuch as the chief engineer is supposed to have the deciding voice, I think this one specification should be altered to read: "Where the drawings and the specifications differ, the chief engineer of the company shall decide which shall govern."

The Chairman: In other clauses in the specification, the chief engineer is given the power of deciding any question which may arise, and it would be a repetition to insert it here.

Mr. Baldridge: It is my idea that it would be better to have a repetition than a conflict. I move that the suggested change be adopted. (Motion seconded, and after considerable discussion was put and lost.)

The Chairman: To forestall some discussion on the subject of clearances, I want to say that the clearance diagram is for the construction of new railway bridges only. It is not intended for general clearance diagrams for the railways or to apply to old bridges. The width of 16 ft. is based on safety and contemplates the use of equipment 11 ft. wide.

W. H. Courtenay (L. & N.): I move that this article be modified to read 15 ft. instead of 16 ft., making other changes to correspond.

(Motion seconded.)

H. T. Welty (N. Y. C.): It seems to me it is inexpedient, at least for this association, to go on record as stating that a lateral clearance of 16 ft. is necessary for safety considering the clearance we get from passing trains and cars on sidings. It immediately puts the roads with bridges having a clearance of 14 and 15 ft. in the position of having structures that are unsafe.

A. W. Carpenter (N. Y. C.): It is permissible to go to greater widths if it is desirable, but instead of having the specification call for 15 ft., have it 15 ft. minimum.

Mr. Courtenay: I will accept that.

Mr. Hunter McDonald (N. C. & St, L.): If I remember correctly, our adopted standard for clearance is 15 ft. It seems to me we are inviting the legislatures to take the position that 16 ft. is necessary, if we enlarge the present clearance. I believe that opinion is crystallizing now on a clearance of 15 ft., and I do not believe we should throw out anything now that would suggest the thought on our part that it is not enough.

(There was further discussion along this same general trend, participated in by A. F. Robinson (A. T. & S. F.), J. L. Campbell (E. P. & S. W.), P. C. Newbegin (B & A.), F. E. Schall (L. V.), G. H. Tinker (N. Y. C. & St. L.), and Chairman Selby, after which the president put Mr. Courtenay's motion and it was lost.)

Mr. Schall: I suggest that the committee explain this matter in the Foreword.

The Chairman: The committee will accept that suggestion.

(The chairman then read the section "Live Load" and called attention the Appendix D, which gives reasons for the adoptoin of the E-60 live loading.)

E. A. Frink (S. A. L.): This specification takes the place of the specification we now have in the Manual, which prescribes Cooper's E-40 loading as the span loading for bridges, and this specifies Cooper's E-60 loading, an increase of 50 per cent in the loading.

There are many points covered in this specification that make a structure designed for certain unit load and designed for certain live load, much stronger than it would have been if it had been built without our load specification, because the changes that have been introduced in the way of refinements and shop practice increase the efficiency of the structure; that is to say, even if the committee did not increase the load, the effect of their specifications would be to produce a stronger structure. In addition to that, they have increased the load.

I move to amend Par. 20 by adding a diagram showing Cooper's E-50 loading and then change the first sentence of Par. 20 to read as follows: The minimum live load for each track shall be as shown in the figures except as provided in Article 21.

The Chairman: I call attention to the fact that Article 21 provides for the use of lighter loadings, including E-50 or anything necessary, down to E-45. In Article 20 the loading given is described as the minimum. This gives the range of loading to be selected by the engineer anywhere from E-45 up to E-90.

B. R. Leffler (N. Y. C.): My idea is that any prediction as to future possible locomotive loadings today is subject to considerable doubt. Another important feature that we should remember is the increase of actual loads on ordinary equipment. The actual loads in freight cars are now as high as 50 tons or even more. We cannot limit the travel of heavy cars. They go on the branches of all the roads in the country. The loadings in the last 15 or 20 years have increased over 50 per cent, and this increase should also be considered, as well as the severe requirement of the specification. Cooper's E-60 should be the minimum for first-class railroads.

A. O. Cunningham (Wabash): I don't believe that we should specify anything higher than E-50 at this time. There are roads that will not require engines much heavier than that for some time to come. There are lots of roads that need much heavier engines. It all depends upon what grades railroads have. You cannot build an engine of E-70 within the limits of the specifications of the distances that you have provided for Cooper's type engines.

Mr. Leffler: Referring to Mr. Cunningham's argument about grades affecting the type or weight of locomotives, I remember a few years ago the opinion was held that the heavy locomotives would be used principally on roads having heavy mountain grades, but we know that low-grade roads in this country will put a locomotive on as heavy as they can so as to pull just as big a tonnage as possible.

Mr. Robinson: Mr. Chairman, I would note that we are using engines which for ordinary length spans give moment and shears better than the E-60 loading. These engines are used on our 0.5 and 0.6 per cent grades.

Mr. Frink: My own idea is this: to put those two loadings on a parity. It is quite true, as Mr. Leffler says, that some of the lowest grade roads in the country are using some of the heavy engines. It is quite true that 10 or 15 years ago no one would have predicted the loading that is being used on certain roads today; but it is also true that there are roads in the country which have built bridges that do not use that loading. Give us a chance to

show that we don't know what we are doing. You infer if we build anything less than an E-60 bridge, that we are not building to good practice. In my judgment it is good practice to build an E-50 bridge, and to build an E-60 bridge when an E-50 bridge will do your work is wasteful, and it is not in accordance with the definition of an engineer which our president quoted yesterday.

Mr. Cunningham: The strength of a bridge depends not so much on the loading as on the specification. The bridges that are being built now under the E-50 loading will take care of any engine that you can put on them, and I would like to go on record as saying that it is impossible to build under these specifications a bridge with E-50 loading that you will break down.

The Chairman: We have tried to get away from the practice of concealing in the specification a provision for increased loading. The live loading shown here, the impact formula and all the other features which affect that part of the design are intended to be honest and truthful. Nobody expects that a bridge built to these specifications to a particular loading would break down with any excess over that loading, but the margin for overloading is only a proper one. It is not the intention to cover up any fictitious margin for overloading by juggling with united stresses or the other features of the specification, so that a bridge designed for particular live loading in these specifications would not have the same margin for overloading as some of the bridges mentioned by Mr. Cunningham, which were designed to unusually low loading, coupled with fictitiously low unit stresses.

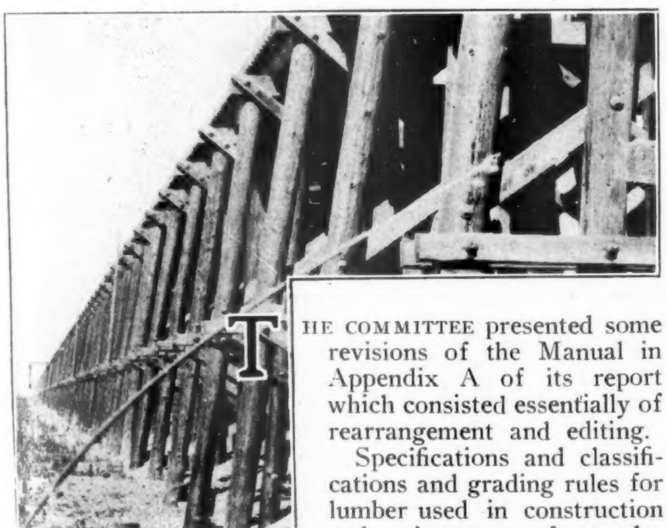
(Mr. Frink's motion was put to a vote and defeated.)

Mr. Welty: The old specification contained an impact formula that covered besides impact other unknown factors, and one of these was the improbability of getting full loads on multiple track bridges. The present impact formula is supposed to take care of the impact question, and in order to cover the improbability of getting full loading on multiple track bridges, a percentage of live loading including impact lower than 100 per cent was adopted. That is perfectly correct in principle, but it seems to me that the percentage given for structures getting their full load from three and four tracks loaded is too low.

F. E. Turneaure (U. of Wis.): If there were no impact whatever and your loadings were absolutely along the roads, there certainly should be a reduction of total loads when you consider the improbability of getting the absolute maximum load on each one of four tracks. The impact percentage in the formula is that which you will get by running a train with a maximum load at just the right speed on a single track. Now, how can you get anything like that impact percentage on a 4-track structure? The percentage of impact should certainly be reduced very greatly, and greater allowance should probably be made in the impact percentage than in the static load itself.

(At this point a number of minor suggestions for changes in the specifications were made, most of which were not approved.) The committee was dismissed with the thanks of the association.

Report on Wooden Bridges and Trestles



THE COMMITTEE presented some revisions of the Manual in Appendix A of its report which consisted essentially of rearrangement and editing.

Specifications and classifications and grading rules for lumber used in construction and maintenance of way departments of railroads were submitted by the committee as a progress report. The committee, however, felt that it should have at least another year to bring together the various opinions and suggestions that have been made by interested parties. In Appendix B are presented density rules and specifications for structural timbers.

Committee: W. H. Hoyt (D. M. & N.), chairman; A. O. Ridgway (D. & R. G.), vice-chairman; H. Austill (M. & O.), F. C. Baluss (D. M. & N.), W. L. Darden (S. A. L.), E. A. Frink (S. A. L.), E. A. Hadley (M. P.), G. A. Haggander (C. B. & Q.), H. T. Hazen (C. N. R.), C. S. Heritage (Wash. Term.), F. S. Schwinn (I. G. N.), I. L. Simmons (C. R. I. & P.), D. W. Smith (H. V.), A. M. Van Auken, D. R. Young (D. L. & W.).

Appendix B—Southern Yellow Pine and Douglas Fir Specifications—Structural Grades for Bridge and Trestle Timbers

Density Requirements

Density Requirements shall contain only southern yellow pine or Douglas fir timbers graded in two grades by the following density rules:

Density Rule for Southern Yellow Pine. Dense southern yellow pine shall show on either one end or the other an average of at least 6 annual rings per inch or 18 rings in 3 inches as measured over the third, fourth and fifth inches of a radial line from the pith, and at least one-third summerwood for girders not exceeding 20 in. in height, and for columns 16 in. square or less. For larger timbers the inspection shall be made over the central 3 in. on the longest radial line from the pith to the corner of the piece. Wide ringed material excluded by the above will be accepted, provided the amount of summerwood, as above measured, shall be at least 50 per cent.

The contrast in color between summerwood and springwood shall be sharp, and the summerwood shall be dark in color, except in pieces having considerably above the minimum requirement for summerwood.

In cases where timbers do not contain the pith, and it is impossible to locate it with any degree of accuracy, the same inspection shall be made over three inches of an approximate radial line beginning at the edge nearest the pith in timbers over three inches in thickness and on the second inch (on the piece) nearest to the pith in timbers three inches or less in thickness.

In dimension material containing the pith but not a five-inch radial line, which is less than two by eight inches in section or less than eight inches on the cross-section, the inspection shall apply to the second inch from the pith. In larger material which does not show a five-inch radial line, the inspection shall apply to the three inches farthest from the pith.

The radial line chosen shall be representative. In case of a disagreement between purchaser and seller as to what is a representative radial line, the average summerwood and

number of rings shall be the average of the two radial lines chosen.

Density Rule for Douglas Fir. Dense Douglas fir shall show, on either one end or the other, an average of at least six annual rings per inch and at least one-third summerwood measured over three inches on a line located as described hereinafter. Coarse-grained material excluded by this rule shall be acceptable provided the amount of summerwood measured as described shall be at least one-half. Material in which the proportion of summerwood is not clearly discernible shall not be accepted.

Any timber whose least dimensions is less than five inches shall not show the pith (heart) on the inspection end; pieces whose least dimension is five inches or more may contain the pith.

When the least dimension is five inches or more, the pith being present, the line over which the rate of growth and per cent of summerwood measurements shall be made shall run from the pith to the corner farthest from the pith. To find the beginning of the three-inch line, measure a distance of one-half the least dimension of the piece, less two inches, from the pith. This distance may be expressed as follows:

$$a = \tfrac{1}{2} d - 2,$$

where a = distance in inches from pith to beginning of three-inch line.

d = least dimension of piece in inches.

When the rings are very irregular it may be necessary to shift the line somewhat around the piece to get a fair average for inspection, but the distance from the pith to the beginning of the three-inch line must not be changed.

For all pieces where the pith is not present the center of the three-inch line shall be at the center of the end of the piece, and the direction of the three-inch line shall be at right angles to the annual rings.

General Requirements. (a) Shall consist of lumber well manufactured, square edges and sawed standard size with only occasional variation in sawing not to exceed ¼ in. scant at time of manufacture allowed.

When the timbers 4 in. by 4 in. and larger are ordered

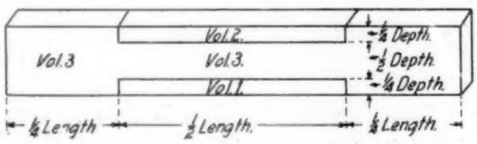


Fig. 1

sized, they will be ½ in. less than nominal size, either S1S1E or S4S, unless otherwise specified.

(b) Structural timbers shall be sound and free from rotten or unsound knots, knots in clusters, decay, round or ring shakes occupying more than one-fourth the least dimension on either end of a timber (a round or ring shake shall be measured on its vertical projection), injurious diagonal grain or other defects that will materially impair its strength.

Knots limited in size and position as hereinafter provided will be permitted if so fixed by growth or position that they will retain their place in the piece as at time of manufacture.

For the limitation of knots in beams in size and location, a beam shall be considered as divided into three volumes as shown in the drawing.

Measurement of Knots. In beams, the diameter of a knot on the narrow or horizontal face shall be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter.

In columns, the diameter of a knot or any face shall be taken as its projection on a line perpendicular to the edge of the timber.

Beams shall not have diagonal or spiral grain in Volumes 1 and 2 with slope greater than 1 in 20; in posts the angle shall not be greater than 1 in 15.

Posts and beams have different restrictions as to knots and angle of grain and must be listed accordingly in bills of material.

No. 1 Structural

No. 1 Structural timbers shall be of dense southern yellow pine or dense Douglas fir, and shall meet the general requirements for structural grades.

This grade shall not have tight pitch pockets over 6 in. long or over ⅜ in. wide or wane exceeding 1 in. on one corner or over one-sixth the length of the piece.

Loose knots larger than ½ in. shall not be permitted.

Beams, Stringers, Girders and Deep Joists. Beams, stringers, girders and deep joists shall show not less than 85 per cent of heart on each side of the four sides measured across the sides anywhere in the length of the piece.

Beams, stringers, girders and deep joists shall not have knots in Volumes 1 and 2 larger in diameter than one-fourth the width of the face of the beam in which they occur, up to and including 6 in., nor larger than 1½ in. in a face over 6 in. Knots within the center half of the length of a beam shall not exceed in the aggregate the width of the surface of the beam in which they occur.

Beams shall not have knots in Volume 3 larger in diameter than one-third the width of the face in which they occur, with a maximum for any one knot of three inches in diameter.

When beams are of two spans length and so marked in bill of materials, Volumes 1 and 2 on inspection shall be considered as extending between points located one-eighth the length of the beam from each end.

The inspector shall place his stamp on the edge of the beam or stringer to be placed up in service.

Caps and Sills. Caps and sills shall show 85 per cent of heart on each of the four sides, measured across the face anywhere in the length of the piece.

Caps and sills shall be free from knots larger than one-fourth the width of the face in which they occur with maximum for any one knot of three inches in diameter. Knots shall not be in groups.

Posts. Posts shall show not less than 85 per cent of heart on each of the four sides, measured across the face anywhere in the length of the piece.

Posts shall not have knots larger than one-fourth the least dimension of the posts nor larger than three inches. Knots shall not be in groups.

Longitudinal Struts or Girts. Longitudinal struts or girts shall show all heart on one face; the other face and two sides shall show not less than 85 per cent of heart, measured across the face or side anywhere in the length of the piece.

Longitudinal struts or girts shall be free from knots over two inches in diameter.

Longitudinal Cross Braces, Sash Braces and Sway Braces. Longitudinal cross braces, sash braces and sway braces shall show not less than 85 per cent heart on two faces.

Longitudinal cross braces, sash braces and sway braces shall be free from knots larger than one-third the width of the face in which they occur, with a maximum of 2 in. in diameter.

Ties and Guard Rails. Ties and guard rails shall show one side all heart; the other side and two edges shall show not less than 75 per cent heart, measured across the surface anywhere in the length of the piece.

Ties and guard rails shall be free from any large knots or other defects which will materially injure their strength; and where surfaced the remaining rough face shall show all heart.

No 2 Structural

No. 2 structural timbers shall meet the General Requirements for Structural Grades, and shall include timbers not passing the No. 1 Grade because of having less density than is required or greater defects than are permitted.

This grade shall not have pitch pockets longer than 12 in. or over ⅜ in. wide or wane exceeding 2 in. on one corner or the equivalent on two or more corners of 10 in. by 10 in. timbers, with wane in proportion on small or large sizes.

Beams, Stringers, Girders and Deep Joists. Beams, stringers, girders and deep joists shall not have knots in Volumes 1 and 2 larger than as follows:

If of dense southern yellow pine or dense Douglas fir, one-third the width of the face of the beam in which they occur, up to and including nine inches, nor larger than three inches in a face over nine inches.

If not of dense southern yellow pine or dense Douglas fir, one-fourth the width of the face of the beam in which they occur, up to and including 6 in., nor larger than 1½ in., in a face over 6 in.

Knots in the center half of the length of a beam shall not exceed in the aggregate twice the width of the surface of the beam in which they occur.

Beams shall not have knots in Volume 3 larger in diameter than one-third the width of the face in which they occur.

Loose knots larger than one-half the size of knots allowed above shall not be permitted; beams shall not have loose knots, in Volume 3, larger than 1½ in.

Caps and Sills. Caps and sills shall be free from knots

larger than one-half the width of the face in which they occur with a maximum for any one knot of three inches in diameter. Knots shall not be in groups.

Posts. Posts shall not have knots, if of dense southern yellow pine or dense Douglas fir, larger than one-third the least dimension of the post, nor larger than four inches; if not of dense southern yellow pine or dense Douglas fir, larger than one-fourth the least dimension of the post, nor larger than three inches.

Longitudinal Struts or Girts. Longitudinal struts or girts shall be free from knots over two inches in diameter.

Longitudinal Cross Braces, Sash Braces and Sway Braces. Longitudinal cross braces, sash braces and sway braces shall be free from knots larger than one-third the width of the face in which they occur, with a maximum of two inches in diameter.

Specifications for Timber to Be Treated

Specifications for timber to be treated are the same as for untreated timber, except that no restriction is to be placed upon the amount of sap wood allowed in the timber which is to be treated.

Many varieties of timber can be used, if treated, that would not be satisfactory to use in the untreated state on account of being subject to rapid decay if they are not treated.

Discussion

W. H. Hoyt (chairman) presented the report and continued as follows: I desire to offer for approval the revision of the Manual as included in Appendix A.

(Motion seconded and carrried.)

(Chairman Hoyt submitted Appendix B specifications for yellow pine and Douglas fir.)

The Chairman: At the present time we simply present Appendix B as a progress report. The committee desires to submit an additional recommendation to those presented in the report, making a total of four suggested pieces of work for next year's consideration.

(The committee was dismissed with the thanks of the association.)

Report of Committee on Ballast

PROPOSED CHANGES in the Manual are shown in Appendix A.

The committee recommended that the paragraph on depth of ballast be rewritten without changing its force or meaning as shown in Appendix 2-A of its report.

A report on the standardization of ballast tools in connection with the work requested by the Standardization committee relative to standardizing ballast tools was shown in Appendix B of the committee's report. It was found from replies to circulars that many carriers have no standards of their own for ballast tools but buy in the open market. The committee had no recommendations to make until further study is given to the subject.

The committee presented a set of "Instructions to Govern Ballasting on an Operated Line" to cover the preparation of the roadbed, skeletonizing the track, renewing ties, providing cross drainage, unloading ballast and lifting track, surfacing and lining track. The committee did not ask for the adoption of these instructions at this time, but proposes to present them again in amended form for final action next year.

The report of the sub-committee is attached as Appendix C.

The committee called attention to the desirability of obtaining data relating to time and cost studies, and particular attention was called to the request of the committee that the cost be expressed in terms of payroll hours per unit of work for the different subdivisions of the work. The committee would like to have the information appear expressed in tabular form and requested that such a record be kept for the coming year by member roads and that the data compiled be filled out in the form suggested and sent to the chairman to be used in compiling the report for the ensuing year.

The committee presented specifications for stone ballast in Appendix E for the consideration and criticism of the membership and asked for written comments and suggestions.

The membership was circularized relative to gravel washing and stone crushing plants and it developed that but few roads owned such plants. The great majority, as indicated by the replies, buy their heavy ballast, such as crushed stone, washed gravel and slag, from privately operated plants, and consider that it is expedient and economical to do so.

The membership was circularized relative to concrete slabs or other devices to assist the ballast and the committee is satisfied that the use of reinforced concrete slabs laid on the roadbed and under the ballast will solve the difficulty experienced over "soft spots." The expense is considerable but not unduly high where the traffic is heavy and the cost of upkeep is reduced to very small proportions.

Conclusions

That the definitions should be rearranged in alphabetical order.

That the depth of ballast should be restated.

That concrete slabs placed under the ballast on soft roadbed where traffic is heavy, and at times under other exceptional circumstances, indicate that a considerable degree of success may be expected from their use, and at reasonable expense.

Committee: H. L. Ripley (N. Y. N. H. & H.), chairman; J. M. Meade (A. T. & S. F), vice-chairman; C. W. Baldridge (A. T. & S. F.), J. S. Bassett, W. J. Bergen (N. Y. C. & St. L.), F. W. Bettle (T. & P.), Theodore Bloecher (B. & O.), H. E. Boardman (N. Y. C.), C. J. Coon (N. Y. C.), T. W. Fatherson (C. G. W.), H. E. Hale (Pres. Conf. Com.), G. H. Harris (M. C.), F. A. Jones (M. P.), J. S. McBride (C. & E. I.), S. B. Rice (R. F. & P.), D. L. Sommerville (N. Y. C.), Paul Sterling (N. Y. N. H. & H.), F. J. Stimson (P. R. R.), D. W. Thrower (I. C.), W. K. Walker (Wabash), R. C. White (M. P.), W. D. Williams (C. N.).

Appendix C—Instructions to Govern Ballasting on an Operated Line

Authority.—Decision of the kind and amount of ballast to be applied having been made by the proper officials, the work should be handled as follows:

Plans.—The division engineer or roadmaster, whichever is to have responsible charge, shall lay his plans for work train movements and service before the trainmaster and chief dispatcher, in order that they may have a clear understanding of what is desired to be done, and that they may be able to assist the movements to be made with as little delay as possible.

Ballast Supply.—If the ballast is to be furnished by the company or from a pit for which the company is responsible, a careful inspection of the pit tracks and appurtenances shall be made and everything put into serviceable condition.

Equipment.—All equipment, such as steam shovel, mechanical unloader, unloading plows, material spreader, ballast plow, or spreader, etc., shall be gone over and put into working order.

Protection.—Speed restrictions shall be arranged for in accordance with operating rules before the track is disturbed, and shall be maintained until the track is in safe condition for schedule speed.

Preparation of Roadbed.—Preparatory to placing ballast, the roadbed shall be widened, if necessary, to bring it to the A. R. E. A. standard width, by dumping material alongside of the track and spreading it to the required width and slope, preferably by the use of a material spreader. Where necessary to raise the roadbed level, porous material must be used to avoid the forming of water pockets by burying in of old ballast. All bank widening shall be done far enough in advance of the ballasting work so that there will be no interference between work-trains or gangs.

Skeletonizing.—After the banks have been widened, and not to exceed two days' work ahead of where new ballast is being dumped, the track shall be skeletonized. Where the material is suitable for sub-ballast and the grade will permit, the track shall be raised and the old material spread under and between the ties, and to the proper width, as uniformly as is practicable.

Where conditions do not permit raising the track, the old material shall be removed to the required depth and disposed of as directed.

Where not suitable for sub-ballast, the old material shall be removed to the plane of the bottom of the ties, or deeper, if necessary, to preserve grade line, and shall be placed on the outer shoulder of the roadbed, preferably at such points as will tend to even up the line of the shoulder.

Use of Jacks. In using jacks, they must be placed close enough together to prevent undue bending of the rail or over-strain of the joints. Where the roadbed material is heavy or holds to the ties tenaciously, it is sometimes necessary to place three or more jacks per rail length. Jacks should be worked in pairs directly opposite each other, and a sufficient number should be used simultaneously, so that no jack will raise the rail more than four inches above its level at the next succeeding jack or place of support.

Tie Renewals. Following the skeletonizing of the track, the tie renewal gang shall take out all old ties which are not fit for more than one year in track, where gravel or cinder ballast is to be used; or for more than three years in track, where stone or hard slag is to be used; and insert new ties in their places. All ties must be properly straightened and spaced.

The track must be fully regaged as the new ties are being spiked up. Old ties must be disposed of, as directed.

Grade Stakes. Ballast grade stakes shall preferably be set after the bank widening, skeletonizing and re-tieing have been done, and before the ballast material has been dumped and spread.

This is desirable to avoid, as far as possible, interference with the stakes, yet to have them available as a guide for the unloading of ballast.

Drains. All tile, box or other drains required to take care of water from between tracks, shall be placed before the ballast material is unloaded.

Unloading of Ballast. Ballast shall be unloaded by dumping or plowing, as the means provided permit.

If the ballast be in center dump cars, it shall be unloaded by having one or more cars opened a little at a time and allowing the required or desired amount of ballast material to flow out as the train is slowly moved along. If the material be on flat or open-side cars, it shall be plowed off by means of an unloading machine while the train is standing or moving at such a rate of speed as to provide the desired amount of material as uniformly distributed as possible.

The unloaded material shall be leveled down by means of a ballast plow, or of a spreader, consisting of a heavy timber with wheel skids attached to it, and placed in front of the leading pair of wheels of the rear truck. Care must be taken not to destroy or disturb the grade stakes.

Parallel Tracks. Where a new track is being built parallel to an existing track, ballast material can be advantageously handled in body dump cars which dump the entire load to the side desired, after which the ballast material may be spread to the required width and depth by the use of a material spreader, and the track laid after the ballast is in place.

Preliminary Surfacing. The first lift shall be a filling lift. The filling, or preliminary surfacing gang, shall follow the unloading as closely as the regularity of the ballast supply will permit.

The amount which the track should be raised at one lift will depend upon the depth of ballast to be applied. Usually, track should not be raised more than 6 in. at a lift, but if the total lift of the track is to be not more than 10 in., a first lift of 7 to 8 in. may be made, if traffic conditions will permit, leaving the remainder of the raise for the finishing lift. A sufficient number of jacks must be used simultaneously to avoid damage to rails. The raise on any one jack shall not be greater than 4 in. above the next jack, or point of support. Both rails must be raised at one time, and as nearly uniformly as is practicable.

The "filling lift" shall be made by jacking the track up to the required height, and the ballast material then forked or shoveled in and worked to as uniform a surface as possible by the use of spades. It shall then be left to be compacted by traffic, but a small "lookout" gang shall go over it after a few trains have passed, and pick up any spots that show too great an inequality of settlement.

After a few days, depending upon the amount of traffic over the track, another lift shall be made—either another filling lift or a finishing lift, according to the depth to which the track is to be ballasted. If another filling lift, it shall be made in the same manner as the first one.

Finishing Lift. When the track has been raised to within two or three inches of the final grade and properly compacted, a finishing lift shall be made by jacking up the track to the exact height provided for by the grade stakes (all allowance for settlement shall be taken care of in the setting of the stakes) and the necessary ballast forked or shoveled in and then driven to place by tamping machines, tamping picks or bars, if rock or heavy ballast is used. Shovel tamping should be used with gumbo, cinder or light sandy gravel ballast. In making the finishing lift, the spot board and level board must be used with care, and the track brought to as true a surface as possible.

Alinement. The track shall be placed in good alinement before the finishing lift is made, but a lining gang shall follow one or two days' work behind the finishing lift and shall spot up all places found not to be holding up to proper surface and shall line the track to as accurate alinement as possible.

Center stakes shall be set for the alinement before the finishing lift is made and the final alinement must conform to the center stakes.

Dressing. Following as closely as possible behind the lining gang, the dress-up gang shall finish the work by filling the track center to the required fullness and then dressing it toward the toe of ballast, preserving the proper clearance under the rail and proper curve and slope of the shoulder. The toe of ballast shall be made a true line, parallel to the center line of track, and any surplus material shall be raked far enough from the toe line to permit of its being forked or shoveled up without fouling or disturbing the finished ballast.

No ballast material or refuse out of the ballast or roadbed material which would interfere with a mowing machine when cutting grass and weeds shall be cast off of the roadbed or be left where it will interfere with the use of mowing machines or scythes.

Clean-Up. When the dress-up gang leaves any part of the track as completed, it shall be in first-class line and surface. The ballast shall conform to the ballast sections as adopted by the A. R. E. A. All surplus ballast shall have been loaded, and all refuse and rubbish shall have been removed, loaded or destroyed, so as to leave the right-of-way and shoulders of roadbed in condition to be mowed without interference.

Appendix E—Specifications for Stone Ballast

General

Stone for use in the manufacture of ballast shall break into angular fragments which range with fair uniformity between the maximum and the minimum size specified herein; it shall test high in weight, hardness, strength and durability, but low in absorption, solubility and cementing qualities.

Tests

Tests shall be made as follows:

Weight. Not less than ½ cu. ft. of the stone accurately measured, and dried for not less than 12 hr. in dry air at a temperature of between 125 and 140 deg. F. shall be weighed. The weight shall not be less than ...... lb. per cu. ft.

Note.—Of the stone available, that having the maximum should be used; a high quality stone for ballast will weigh 168 lb. per cu. ft.

Strength. Two-inch cubes of the stone shall be sawed to

reasonably accurate dimensions and the top and bottom faces made accurately parallel. For the primary tests, the test specimens shall be dried for two hours in dry air at a temperature of between 120 and 140 deg. F. and at the time of test the temperature of the specimen shall be not less than 50 deg. Tests shall be made in a testing machine of standard form and the stone shall have a compressive strength of ..... lb. per sq. in.

Note.—Of the stone available, that having the maximum compressive strength should be used; a high quality stone for ballast will have a strength of 10,000 lb. per sq. in.

A secondary test shall be made on specimens the same in all respects as for the primary test except that the blocks shall have been completely immersed in clean water, of a temperature between 35 and 40 deg. F. for 96 hr., the test to be made within 30 min. of removal from the water.

If the compressive strength shall have decreased more than ...... per cent. from the primary tests, the rock shall be deemed unsuitable for ballast purposes.

Note.—Of the stone available, that showing the least difference between the results of the primary and secondary test should be used; a high quality stone for ballast should show not over one per cent. difference.

Solubility. One-fourth cubic foot of the rock shall be crushed and thoroughly washed. The particles shall then be placed in a glass vessel and covered with clear water. The vessel shall be thoroughly shaken for five-minute periods at 12-hr. intervals for 48 hr. If any discoloration of the water occurs, the rock shall be deemed soluble and undesirable for use as ballast.

Test No. 1

Wear or Durability. One-half a cubic yard of washed stone, which will pass through the maximum and be retained on the minimum screen, shall be spread over a wire mesh or iron surface to a depth of not more than three inches, and exposed to a dry heat of from 125 to 140 deg. F. for a period of two hours. After the dried stone is carefully weighed it shall be given 10,000 revolutions in a tumbler approximately four feet in diameter, of not less than two cubic yards capacity, and operating at 25 r.p.m.

The sample shall then be passed over a screen of the minimum dimension provided for sizing the ballast, again washed and dried in the same manner as before the test, and again carefully weighed.

If the decrease in weight shall be more than ..... per cent. of the original weight of the sample, the stone shall be deemed unfit for use as ballast.

Outside of the breakage, which is exhibited by the small particles which will pass through a minimum screen but will not pass a sieve of 20 meshes to the inch, the wear should not exceed ...... per cent.

Note.—Of the stone available, that showing the smallest loss in weight should be used; a high quality stone for ballast will show a loss of not more than 1 per cent in fragments which will pass a screen of 20 meshes to the inch, and not more than 3 per cent in those passing the minimum sizing screen.

Test No. 2 (Quick Weathering Test)

One-half a cubic yard of stone shall be dried and weighed as for Test No. 1. It shall then be immersed in water for six hours and then while still wet, be placed in a refrigerating plant and subjected to a temperature of approximately zero Fahrenheit for two hours. It shall then be removed and the temperature gradually raised in two hours to 100 degrees and that heat continued for two hours, when it shall be immersed as before and again subjected to approximately zero temperature.

The freezing and thawing shall be repeated to a total of 10 exposures. If any tendency to disintegrate is observable the stone should be considered unsuitable for ballast. Otherwise the material shall again be subjected to a wear test as provided under Test No. 1. If in this wear test the maximum decrease in weight shall be in excess of ...... per cent, it shall be deemed unsuitable for use as ballast.

Note.—Of the stone available, that showing the minimum average decrease in weight should be used; a high quality stone for ballast will not show a decrease in fragments which will pass the minimum sizing screen of more than 4 per cent.

Absorption

One-half a cubic yard of washed stone, which will pass through the maximum and be retained on the minimum screen, shall be spread over a wire mesh or iron surface to a depth of not more than three inches, and exposed to a dry heat of from 125 to 140 deg. F. for a period of six hours. After the dried stone is carefully weighed it shall be submerged in clean water for a period of 96 hr. It shall then be removed from water and exposed to a normal air in the shade and at a temperature between 40 and 80 deg., and allowed to drip for 30 min., when it shall again be weighed and the difference in weight shall be used to determine the rate of absorption. Stone showing an absorption of more than ...... lb. per cu. ft. is unsuitable for ballast.

Note.—Of the stone available, that showing the minimum absorption should be used; a high quality stone for ballast will have an absorption of not more than 0.50 lb. per cu. ft.

Cementing Quality

A five-pound sample of the rock thoroughly washed and dried shall be crushed until it will pass through a screen of ¼ in. mesh. This material shall be placed in a bill mill which contains two steel shot weighing 20 lb. each, and the mill revolved at the rate of 30 r.p.m., until it has made 2,000 revolutions for each pound of sample in the mill.

Sufficient clean water shall be added to make a consistent mortar, which shall then be molded into one inch cubical briquettes, formed under 10 lb. pressure. All of the briquettes shall then be allowed to dry 20 hr. in air, when one-third of them shall be tested for compressive strength.

One-third shall be kept for four hours in a steam bath, and the remainder shall be immersed for four hours in clean water at a temperature between 50 and 60 deg. F. and then tested for compressive strength.

If in any of these tests a compressive strength greater than ...... lb. per square inch is developed, the material shall be deemed unsuitable for ballast.

Note.—Of the stone available, that from which the briquettes show the minimum strength should be used; a high quality stone will show not to exceed 4 lb. per sq. in.

Breaking

Stone for ballast shall be broken into fragments which range with fair uniformity between the size which will in any position pass through a 2½-in. ring and the size which will not pass through a ½-in. ring.

Test for Size

Maximum. A sample weighing not less than 150 lb. shall be taken from the ballast as loaded in the cars and placed in or on a screen having round holes 2¾ in. in diameter. If a thorough agitation of the screen fails to pass through the screen 95 per cent of the fragments, as determined by weight, the output from the plant shall be rejected until the fault has been corrected.

Minimum. A sample weighing not less than 150 lb. shall be taken from the ballast as loaded in the cars; weighed carefully and placed in or on a suitable screen having round holes ½ in. in diameter. The screen shall then be agitated until all fragments which will pass through the screen have been eliminated. The fragments retained in the screen shall then be weighed and if the weight is less than 95 per cent of the original weight of the sample, the output of the plant shall be rejected until the fault is corrected.

Handling

Broken stone for ballast must be delivered from the screens directly to the cars or to clean bins provided for the storage of the output of the crusher. Ballast must be loaded into cars which are in good order and tight enough to prevent leakage and waste of material and are clean and free from sand, dirt, rubbish or any other substance which would foul or damage the ballast material.

Inspection

Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the ballast material is prepared and loaded in accordance with the specifications and contract.

In case the inspection develops that the material which has been or is being loaded is not according to specifications, the inspector shall notify the manufacturer to stop further loading and to dispose of all cars under load with the defective material.

As the quarry deepens or is enlarged, further tests shall be made of the material wherever conditions indicate a change in the quality of the stone, or where in the judgment of the engineer for the company, a further test is advisable. Should such tests show that the stone fails to meet the pro-

visions of these specifications, it shall not be used for the manufacture of ballast.

MEASUREMENT

Ballast material may be reckoned in cubic yards or by tons as expedient. Where ballast material is handled in cars, the yardage may be determined by weight, after ascertaining the weight per cubic yard of the particular stone in question by careful measurement and weighing of not less than five cars filled with the material, or the tonnage may be determined for subsequent cars by measurement and converting the yardage into tonnage by use of the weight per yard as determined above.

Discussion

H. L. Ripley (chairman) presented the report.

R. H. Ford (C. R. I. & P.): I would like to ask the committee if they would be willing to consider an addition to the definition of ballast by inserting the words "improving drainage and," making it read: "Selected matter placed on the roadbed for the purpose of improving drainage and holding the track in line and surface."

The Chairman: I don't know what the other members of the committee will say, but I think that definition needs a more extensive revision than just the insertion of that language.

Mr. Ford: I would like to suggest one of two things. One is that the committee agree to take that addition, or else that they consider it in reviewing it prior to insertion in the Manual. I believe that ballast is something for some other purpose than merely holding the track in line and surface.

The Chairman: I would like Mr. Ford or other members to give us constructive criticism of these definitions and suggestions to other definitions.

The President: These definitions presented involve no changes at all from those that are now in the Manual. It is merely a rearrangement in alphabetical order, and to undertake now to revise these definitions would consume too much time.

The Chairman: I move that the paragraphs as they are in the Manual, under "depth of ballast," be rearranged under the caption, "Proper depth of ballast," as it appears at the top of Appendix A-2, and that the paragraphs recommended by the committee be substituted for the language that follows the original caption.

The President: Do I understand that all the paragraphs you have enumerated replace the same paragraphs in the Manual?

The Chairman: It replaces the paragraphs that come under proper depth of ballast, and covers the subject-matter contained in this rearrangement and restatement of that material.

(Motion seconded and carried.)

The Chairman: I move the adoption of the portion of the committee's report under the caption: "Gravel washing and stone crushing plants," commencing "The desirable points to be considered," to be inserted in the Manual.

(Motion seconded.)

C. J. Coon (N. Y. C.): Most of the committee was over the Richmond, Fredericksburg & Potomac in the fall and made a critical examination of the conditions there, washed gravel ballast having been used for many years. The indications were that that road was getting a very much better wear out of the rail, owing to the fact that it had splendid drainage from the washed gravel ballast. A great many roads are increasing the weight of their rails, and this does not take care of the situation, for you cannot do it all with the rail. You must take care of some of it with the tie, the increased depth of ballast and a better class of ballast. Temporarily, in a territory where you cannot get good stone, the next best thing, in the opinion of the committee, is to wash the ballast.

Hunter McDonald (N. Y. C. & St. L.): I have heard it stated, not on this floor, but lately, that gravel ballast was unsuitable for the very high class and high speed traffic that we have nowadays. In fact, I note a tendency to condemn the use of gravel, whether washed or not, in favor of limestone ballast.

(Motion carried.)

The Chairman: The committee would recommend that the Conclusion in Appendix G, stating: "Concrete slabs placed under the ballast on soft roadbeds where traffic is heavy, and at times under other exceptional circumstances, indicate that a reasonable degree of success may be expected from their use and at a reasonable expense," be inserted in the Manual.

H. E. Boardman (N. Y. C.): It was a little difficult to get the information on concrete slabs, but enough information has been assembled to show a decided opportunity for the use of the reinforced concrete slab on soft ground in locations where excessive cost of maintenance has taken place.

The Chairman: Regarding Appendix C, "Instructions to Govern Ballasting on an Operated Line," the committee suggests that, during the next few weeks, the members read this method of procedure, or rules to handle the ballast gang, and suggest criticisms to the committee so that at the next meeting they can then be presented for adoption. In connection with Appendix D, "Time and Cost Study in Connection with Ballast Work," Mr. Baldridge is sending out a circular letter asking the members to keep a record of the ballast work which they will do during the coming summer. This study is to be expressed in terms of units of work and units of time rather than in dollars.

Mr. Ford: I wonder if the committee realizes how difficult it is to go out and get any information that is really susceptible of analysis through time, study and cost data report, and I cannot see that it will be of very much value when they get it. It is too analytical. We are not ready for it. We do need cost data work, but we need something that will enable the ordinary track gang to report the information with reasonable accuracy. The report of cost data should be prepared in such manner that it will reflect what it does cost as a practical matter to handle ballast.

C. W. Baldridge (A. T. & S. F.): The reason the committee is asked for information in the detail we have shown here is because if we ask for a figure for the completed cost of ballast, each person reporting will include different items, and we do not get comparable results.

The Chairman: Through inadvertence, the name of F. J. Stimson did not appear as the chairman of the subcommittee on Appendix E, "Specifications for Stone Ballast." At the present time many of the figures in the specifications simply rest on the opinion of the members of the committee. It is hoped that some of the universities will consider this matter of sufficient interest to take it up in their laboratories and make the tests.

F. J. Stimson (P. R. R.): There has been no attempt to draw a specification that will describe what are ideal ballasts, and for that reason you will find running through the specification, notes calling attention to the limits of various qualities which are named as being desirable. In these limits we have used figures which are largely empirical. They are merely the best opinions we could gather.

(The committee was dismissed with the thanks of the association.)

Report on Stresses in Railroad Track

THE SPECIAL COMMITTEE on Stresses in Railroad Track (a joint committee of the American Railway Engineering Association and the American Society of Civil Engineers) presented its second progress report. The committee divided its report between (1) tests to determine the effect of speed and counterbalance on stresses in rail; (2) track depressions; (3) depression, flexure and bearing pressure of cross ties; and (4) transmission of pressures in ballast. This report, which had also been presented before the annual meeting of the American Society of Civil Engineers in New York in January, was published in the *Railway Age* of March 5 and 12.

Committee: A. N. Talbot (Univ. of Ill.), chairman; W. M. Dawley (Erie), vice-chairman; A. S. Baldwin (I. C.), G. H. Bremner (I. C. C.), John Brunner (Ill. Steel Co.), W. J. Burton (M. P.), Charles S. Churchill (N. & W.), W. C. Cushing (P. R. R.), Dr. P. H. Dudley (N. Y. C.), H. E. Hale (Pres. Conf. Com.), Robert W. Hunt, J. B. Jenkins (B. & O.), George W. Kittredge (N. Y. C.), Paul M. LaBach, C. G. E. Larsson (Am. Pr. Co.), G. J. Ray (D. L. & W.), Albert Reichmann (Am. Pr. Co.), H. R. Safford (C. B. & Q.), Earl Stimson (B. & O.), F. E. Turneaure (Univ. of Wis.), J. E. Willoughby (A. C. L.).

Discussion

(A. N. Talbot (chairman) presented the report and read various abstracts from it, giving some informal explanations.)

John R. Leighty (M. P.): I would like to ask if you have found that stress in the rail at any given speed follows directly the weight of the load. What I am trying to get at is something to explain in my own mind if you can find a different per cent of increase for different types of locomotives and different types of tenders.

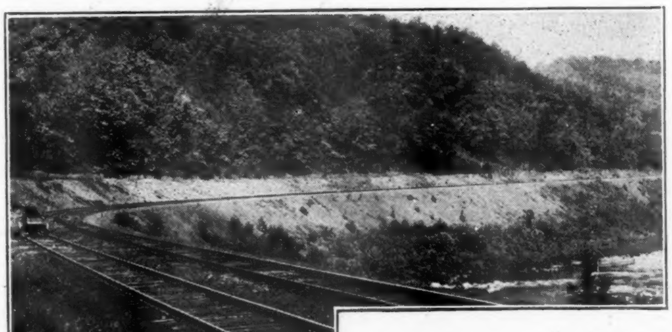
The Chairman: We do not know, of course, what the weight on these tenders was. They were taken rather as material which we thought would be of value. It is evident that a tender, and perhaps that applies also to loaded cars, has a higher effect of speed that the heavier loaded axles do.

Mr. Leighty: In examining some data, which was crudely obtained, which had to do with the depression of rail under moving loads, it was quite apparent that the depression was not in direct ratio to the load.

The Chairman: So far as depression is concerned, we have not been able to make any measurements. The question comes up how far this impact effect, due to speed, goes, how far down into the ballast it gets, how much of it is taken up by the tie and by the bending of the tie throughout the length. I feel that there must be an increased track depression. I hope that this season we shall be able to make some tests which will determine rather definitely to what extent it exists.

(The committee was excused, with the thanks of the association.)

Report of the Committee on Roadway



THE COMMITTEE submitted a number of proposed changes in the Manual which consisted principally of revisions of definitions and the addition of a few new definitions.

The committee also presented the results of its consideration of subsidence under embankments in Appendix B; of the shrinkage of embankments in Appendix C; and the unit pressure allowable on roadbeds of different materials in Appendix D.

Committee: J. R. W. Ambrose (Tor. Term.), chairman; J. A. Spielmann (B. & O.), vice-chairman; C. W. Brown (L. & N. E.), B. M. Cheney (C. B. & Q.), C. W. Cochran (Northwestern Univ.), W. C. Curd (Cons. Engr.), W. M. Dawley (Erie), Paul Didier (B. & O.), S. B. Fisher (M. K. & T.), W. C. Kegler (C. C. C. & St. L.), J. A. Lahmer (M. P.), J. G. Little (Ry. Age), H. W. McLeod (C. P. R.), C. M. McVay (K. & M.), F. M. Patterson (I. C. C.), W. H. Petersen (C. R. I. & P.), P. Petri (B. & O.), R. A. Rutledge (A. T. & S. F.), W. H. Sellew (M. C.), J. M. Sills (St. L. S. F.).

Appendix B—Subsidence Under Embankments

Subsidence, or hidden quantities, as one road calls it, is that portion of the embankment that lies below the original surface of the ground. There is apparently more subsidence than has been generally supposed, and until recently it has only been supposed to occur in places where the foundation was known to be of an unstable nature. However, the study made by the committee, covering reports made upon some hundreds of miles of line, indicates that subsidence exists to a greater or less extent under all embankments; not only was grading material found, but the investigation disclosed quantities of cribbing, mattress work and timber of all kinds, of which no definite record is kept.

The methods usually employed to determine the amount of subsidence are: trenching, auger borings and wash borings.

Trenching is used only through light embankments and at the toe of larger ones. Auger borings are made in fills where the material is of such a character that the earth auger will penetrate and bring up the material. Usually a protecting pipe casing is driven through the loose material and the auger operated through this pipe. Wash borings are made when the depth is too great or when the material will not permit the use of the earth auger.

In determining the amount of subsidence, cross-sections are taken at such intervals as is thought necessary by reason of the character of the surface over which the embankment is constructed, i. e., usually a test hole is made at the shoulder, on the slope and possibly in the center of the embankment; from these tests the surface of the original ground is located, and from the notes taken a cross-section is platted and the yardage calculated in the usual manner.

After the subsidence is calculated in order to determine the equivalent amount of excavation, a percentage (depending on the material) should be added for shrinkage; the committee has found shrinkage in embankments to average approximately ten per cent.

The costs per foot of hole bored, as indicated by the

reports received, varied from 33 cents to 55 cents; the cost per cubic yard of subsidence from 0.2 cents to 1.2 cents.

The committee studied the effect of different subsoils on subsidence with the object of establishing a relation of subsidence to height of fill; while the individual cases spread over a wide range, it is interesting to note that the average seems to be 1 per cent subsidence per foot of fill height, thus a ten-foot fill would give 10 per cent subsidence, i. e., 10 per cent of the original embankment.

In order to find out whether subsidence occurred to any extent under all embankments, one of the roads made an investigation in localities where there was no indication of or reason to believe that there was subsidence, with the surprising result shown in the following table:

Length in Feet	Embankment in Cubic Yards: 10 Ft. and Under	Over 10 Ft. Under 20 Ft.	20 Ft. and Over	Subsidence in Cubic Yards: 10 Ft. and Under	Over 10 Ft. Under 20 Ft.	20 Ft. and Over	Per cent of Increase
1,350	......	29,399	......	......	6,138	......	20.8
1,570	......	27,355	......	......	8,117	......	29.7
3,270	......	93,695	......	......	29,669	......	31.8
1,600	5,161	......	......	2,018	......	......	38.7
800	7,550	......	......	2,752	......	......	36.5
6,450	......	154,031	......	......	38,355	......	24.8
1,225	18,039	......	......	13,723	......	......	72.5
1,725	......	37,586	......	......	12,062	......	32.1
2,200	24,224	......	......	4,309	......	......	17.7
370	3,105	......	......	1,382	......	......	44.5
4,250	24,098	......	......	16,083	......	......	66.5
2,010	6,032	......	......	5,774	......	......	96.0
2,450	30,204	......	......	16,073	......	......	53.2
3,660	12,415	......	......	9,303	......	......	74.9
9,500	74,452	......	......	38,538	......	......	51.6
3,570	......	77,522	......	......	23,450	......	30.2
1,900	9,608	......	......	5,525	......	......	57.5
510	9,401	......	......	2,169	......	......	23.0
3,870	39,790	......	......	11,141	......	......	27.9
1,380	10,359	......	......	2,984	......	......	28.7
3,050	......	55,772	......	......	12,021	......	21.5
1,350	......	27,611	......	......	8,086	......	21.4
1,260	8,671	......	......	2,601	......	......	30.0
390	1,271	......	......	1,044	......	......	82.1
600	2,369	......	......	1,558	......	......	65.6
840	3,949	......	......	2,295	......	......	58.0
7,190	......	......	284,272	13,602	4,951	32,365	17.8
1,450	......	12,355	......	......	3,813	......	30.8
1,900	30,195	......	......	8,016	......	......	26.6
670	755	......	......	704	......	......	93.3
1,700	5,563	......	......	1,009	......	......	18.0
1,940	......	25,796	......	......	4,793	......	18.5
740	......	17,803	......	......	3,441	......	19.3
1,350	......	11,869	......	......	3,900	......	32.8
650	1,384	......	......	1,156	......	......	83.5
620	3,405	......	......	616	......	......	18.0
750	967	......	......	316	......	......	32.7
640	......	7,057	......	......	1,919	......	27.2
425	......	10,718	......	......	5,210	......	48.6
315	1,935	......	......	606	......	......	31.3
370	1,633	......	......	255	......	......	15.8
650	1,741	......	......	528	......	......	30.3
7,310	34,930	......	......	16,284	......	......	46.5
170 Miles	373,206	588,569	284,272	181,764	165,931	32,365	....
				48.5%	28.2%	11.4%	

The land upon which these embankments were constructed was originally marshy and covered with very heavy loam, but now has been thoroughly drained and the casual observer would have no reason to suspect that subsidence had occurred.

When one considers the conditions resulting from operation and the maintenance of track structure, it is apparent that there must be subsidence under all embankments, varying from an infinitesimal amount when founded on solid rock to a very great quantity in certain sinks. The committee found one instance of an almost unlimited subsidence in a cut. Although they have not been asked to make a recommendation, the committee wish to emphasize the importance of due consideration being given to the matter of subsidence when revaluation surveys are being made.

Appendix C—Shrinkage of Embankments

At the convention in 1917 the Roadway committee made a report on the width which it was advisable to construct new roadbed on embankments 50 feet or more in height. In the above report it was recommended that no allowance be made in height, and a rule was given for the widening of such embankments, taking into account anticipated shrinkage.

Reliable information received from the Interstate Commerce Commission and from varoius railroads furnishing information to the Valuation Department of the Interstate Commerce Commission show many and vastly different results in the shrinkage of embankment and swelling of excavation. Cases are cited showing the swell of rock excavation ranging from 6 per cent to 48 per cent.

The following statement summarizes the information received:

AVERAGE SWELL AFTER PLACED IN EMBANKMENTS

17 cases solid Rock excavation taken from South and West	25.2%
15 cases 90% Rock 10% Earth taken from South and West	31.5%
7 cases 80% Rock 20% Earth taken from South and West	17.1%
17 cases 70% Rock 30% Earth taken from South and West	18.9%
8 cases 60% Rock 40% Earth taken from South and West	13.9%
7 cases 50% Rock 50% Earth taken from South and West	16.6%
9 cases 40% Rock 60% Earth taken from South and West	5.5%
7 cases 30% Rock 70% Earth taken from South and West	*3.0%
7 cases 20% Rock 80% Earth taken from South and West	*0.1%

*Decrease.

These figures are substantiated by figures on granite excavation by the Central Vermont in Massachusetts, showing this granite to swell when placed in an embankment 31.86 per cent to 35.8 per cent. The same road also shows a shrinkage of 12.27 per cent with stiff blue clay and 7.76 per cent on fine, dry sand when placed in embankment. The sections on this work were taken immediately on completion of the grading and before track had been laid. All the above work had been done by dumping from temporary trestle.

In 21 cases, covering the country generally and representing a number of localities, we get an average shrinkage of 10.4 per cent. In round numbers, three million cubic yards are represented in these figures. The height and weather conditions are not of record and the fills were constructed in various manners, such as dumping from trestle, teams and scrapers, steam shovel and dump wagons.

Practically all the material represented is clay mixed with sand in various quantities. As quite a number of fills were constructed by several different methods on the same fill, it is not possible to establish a reliable percentage of shrinkage for the different methods of construction, but the individual cases vary from 15.1 per cent shrinkage in an instance where construction was performed by cars and stationmen to a 1.8 per cent shrinkage in a fill built by teams and scrapers.

It would seem from the figures submitted that an estimated shrinkage of 10 per cent is the best that can be done when handling roadway construction of earth composed of clay and sand, common to nearly all localities.

Shrinkage or settlement, of course, will start at once after the material is placed in embankment, but will be much more rapid after traffic is turned over the fill. The investigations of this committee substantiate the rule that earth occupies less space when placed in embankment than before excavated and rock swells when excavated and occupies more space.

The general conclusions reached from the investigation of the subject assigned to this sub-committee are as follows:

(1) Figure a swell of at least 25 per cent for solid rock removed from excavation to embankment.

(2) Figure a shrinkage of 10 per cent on earth removed from excavation and placed in embankment.

(3) Excavation and embankment composed of both rock and earth in mixed quantities should be estimated proportionately, using above rules.

These rules should be used with care and judgment, as there is no way of evading the fact that shrinkage

does not always occur to this extent or that more shrinkage may take place than anticipated. It is, however, well enough established by observation that it is fair and safe to anticipate these results in preliminary estimates.

Appendix D—Unit Pressures Allowable on Roadbed of Different Materials

Before any conclusion could be drawn by the committee on this subject it was necessary to know the extent, distribution and amount of pressure on the subgrade developed by the traffic passing over the same. The attempts at measurement of these pressures developed under traffic, and of the depression of the subgrade under load, made by the Joint Committee on Stresses in Track, were not successful enough to warrant the use of the results obtained or even to encourage further work in that direction.

A large amount of laboratory work has been done by the Joint Committee on Stresses in Railroad Track in the investigation of the distribution of pressures for different depths of ballast, and after conferring with A. N. Talbot, chairman of that committee, the following is submitted for your consideration:

Variation in Pressure Over Roadbed for Different Depths of Ballast

"(a) For a depth of 12 in. of ballast the maximum pressure on the roadbed may be said to be as much as 2.75 times the pressure obtained by considering the load to be uniformly distributed along the roadbed for a width equal to the length of the tie.

"(b) For a depth of 18 in. of ballast the maximum pressure on the roadbed may be said to be at least 1.6 times the average pressure on the area above referred to.

"(c) For a depth of 24 in. of ballast the pressure on the roadbed may be considered to be not far from the average pressure over an area of roadbed having a width 6 in. wider than the length of a tie."

The foregoing is based upon a tie spacing of, say, 21 in. center to center, and ties 8 ft. or 8 ft. 6 in. long. It is intended to represent results on well-kept track in good condition. The pressures considered are static pressures; the effect of vibration and impact will need to be taken into account in determining the load which any roadway will carry satisfactorily.

As an illustration, consider a locomotive having axle loads of 60,000 lb. spaced 5 ft. 6 in. apart. The average pressure on a width of roadbed of 8 ft. 6 in. would be 1,280 lb. per sq. ft. A maximum of 2.75 times this is 3,520 lb. per sq. ft. If the impact effect increases the effect of the load 50 per cent the pressure would be 5,280 lb. per sq. ft. Allowance for additional pressure due to counterbalance might give a large further increase. It is seen that the pressure on the roadbed may be very high under some conditions.

Allowable Pressure on Roadbed

The pressure which a roadway can carry will, of course, depend upon the nature and properties of the material of which it is composed, and upon its condition with respect to moisture, frost, etc. No tests have been made by the committee on complicated and difficult questions.

No definite results have been obtained on what pressures are developed on roadbed in practice, or on the deformations due to load or whether full recovery is generally obtained. In fact, it seems likely that little more can be found by tests on the roadway itself than to check up in a general way the deductions obtained from the laboratory tests and from analysis. The pressures which different materials will carry must also be got at in another manner.

The pressures above mentioned are averages of the individual readings taken at many points on the subgrade under the ties. The current report of the Joint Committee on Stresses in Track shows the variation in pressure both longitudinally and transversely of the tie for 12 in. depth of sand ballast and for loads of from 21,000 to 40,000 lb. on the tie. It also shows lines of equal vertical pressure under three ties spaced 21 in. center to center and demonstrates that at a depth equal to or slightly in excess of the tie spacing the pressure becomes practically uniform, at 38 per cent of the average pressure of the tie or not far from the average pressure over an area of roadbed having a width 6 in. wider than the length of a tie.

If the pressure on the roadbed be computed by taking the load uniformly distributed along the roadbed for a width equal to the length of the tie and this be increased by from 50 to 75 per cent for impace, vibration and effect of counterbalance and this result multiplied by 2.75 for 12 in. of ballast, 1.6 for 18 in. or by 1.0 for 24 in. of ballast, maximum pressures will be obtained which the roadbed will be called upon to sustain without undue deformation or settling. There is a dearth of information as to what pressure various soils will sustain at such shallow depth as from 1 to 2 ft. Such materials, if available, should be chosen for the roadbed as modern building practice has demonstrated will carry the loads computed as above.

Discussion

J. R. W. Ambrose, chairman, presented the report and moved the acceptance of matter on revision of the Manual.

(Motion carried.)

The Chairman: The next subject is "Subsidence Under Embankments." This is submitted for information only.

W. H. Courtenay (L. & N.): I do not want to dispute the committee's finding, but that result in the seventh paragraph of Appendix B looked to me rather startling, to have a 50-ft. embankment with 50 per cent of the earth under the natural ground surface.

The Chairman: I do not believe that is intended to cover any limited height. We have a number of cases cited where the subsidence was far in excess of 50 per cent, up to 75 per cent, and over 100 per cent. It is the result of a number of cases, which probably covered 100 miles.

Mr. Courtenay: In marshes we have cases, shown by borings, where there is more embankment below the marsh than above, and strange to say it was green matter, put there when the road was constructed in 1869, and still green. I know certain cases where the amount of material has been enormous that has gone through the swamps, but in ordinary ground I do not think the subsidence is so great.

The Chairman: I am glad you took exception to that, because the committee was startled to find the comparative indifference of the majority of engineers regarding this subject.

Hadley Baldwin (C. C. C. & St. L.): The percentages in Appendix C are averages, as I understand, of all the data that was submitted to the committee. The average of the country at large might be entirely misleading as to a particular locality or particular railroad.

H. L. Ripley (N. Y. N. H. & H.): The average percentages are very likely to be misleading if you do not differentiate between the soft rocks, shales and soft sandstones, and the hard traps and granites. From the investigations we have made, we feel sure that the swell in the softer rocks will not exceed 15 per cent. We feel

equally sure that the New England granites will swell approximately 40 per cent.

C. M. McVay (K. & M.): In measuring swell rock, there were examples which ran from 3 or 4 per cent up to 60 per cent or more. In earth the variance was not so large, but showed a shrinkage all the way up from 1 or 2 per cent to 18 and 20 per cent.

Mr. Ripley: I think if you will make a study of it, you will find that a variation does follow roughly the degree of hardness of the rock. It is influenced by many things, the way you shoot it, and the way it is put into the fill. No degree of precision can be reached, but it seems that the fact is pretty well established from the studies we have made that perhaps an average swell for a soft rock—I do not mean paper shell, but a rock, real rock—which is soft and breaks up finely and much of it disintegrates until it becomes of an earthy consistency, will show approximately 15 per cent. I think it is equally true that rock of the character of granite will swell approximately 40 per cent.

J. L. Campbell (E. P. & S. W.): This is a case in which averages are dangerous things to use. If it is a problem of laying the grade line so as to balance the quantities, it will be necessary to consider the individual excavation in connection with the embankments affected and the specific character of that material.

E. F. Wendt (I. C. C.): I ask the committee what is represented by the 10 per cent which they suggest for shrinkage?

Mr. McVay: I think that is the 10 per cent additional yardage required in the construction of the embankment over the amount taken out of the excavation; in other words, approximately 100,000 yd. of earth in excavation would shrink to approximately 90,000 yd. when placed in the embankment.

G. H. Bremner (I. C. C.): May I ask if the committee eliminated all the subsidence from this shrinkage?

The Chairman: The shrinkage in this case has nothing at all to do with subsidence, because we are figuring shrinkage here before you actually get it.

Mr. Wendt: Are you following the definition in the Manual when you say that the average amount of shrinkage is 10 per cent?

The Chairman: I would say we are, in the case of the example cited, 100,000 yd. of excavation, we have not this amount exactly, but we know we will get that much from the cross sections, and we also know, by calculating 10 per cent shrinkage, we are only actually going to have a corresponding embankment of 90,000 yd.

Mr. Wendt: What we understand generally from engineers is that the percentage represents, not exactly the contraction of material, but the difference between the amount in the first instance and the amount which remains some years after the embankments have settled and they have reached their natural slopes. If that is the case, the difference is not the contraction only, but something else has taken place.

R. H. Ford (C. R. I. & P.): I am familiar with one case that may be of value. We constructed on the Rock Island a few years ago a track elevation embankment from 20 to 40 ft. high, enclosed by concrete walls, so that there was no possibility of material getting out on either side. We undertook in building to immediately shrink the material by turning water on the embankment for 10 days.

The shrinkage, as near as we could calculate, was 10 per cent. In investigating the matter, to ascertain whether it was really 10 per cent. or 12 per cent. or 8 per cent., I regret to say we were not able to confirm our conclusions of 10 per cent.

Mr. Alfred: I wonder if there is any objection on the part of the gentlemen representing the Interstate Commerce Commission to let us know what formula they have used in determining shrinkage and what formula they have used in determining subsidence.

Mr. Wendt: So far as subsidence is concerned, there is no formula. That is a matter of estimate. So far as shrinkage is concerned, engineers do not seem to know what the amount of shrinkage is. A rule which is being followed is that the maximum amount is 10 per cent., and furthermore, it is not considered that this is a contraction of the material but that it is the difference between the original amount in its natural condition, and that same amount in the embankment after it has reached its settled condition after the slopes have become natural and after there has been some loss due to the washing and wasting caused by the weather.

The Chairman: I move that Sections (b), (c) and (d) be accepted as information for incorporation in the proceedings.

(Motion seconded and carried.)

The committee was dismissed with the thanks of the association.

Report of Committee on Wood Preservation

In Appendix A the committee submitted changes in the Manual. In Appendix B it submitted the record of the results of the preservative treatment of cross-ties on the Delaware, Lackawanna & Western.*

The committee has never submitted a specification for water gas tar for use by itself, but in this year's report covering the preservative treatment with zinc chloride and creosote oil, two specifications, one for water gas tar solution and the other for water gas tar distillate, are submitted, in view of the fact that the use of these oils has become recognized as good practice.

In Appendix D of its report the committee presented a brief statement on the progress made with the process for perforating timbers to increase penetration with preservatives.

In Appendix E the committee submitted as information a new indicator for determining the penetration of zinc chloride in ties and timbers treated by the Burnettizing process, the directions covering which were recommended for adoption as standard practice under the heading of "Conclusions."

In Appendix F the committee reported on the availability of sodium fluoride and recommended its trial by those railroads interested in water soluble preservatives.

In Appendix G the committee gave what it feels is the present knowledge of the values of the different creosote oils.

Appendix I gives certain observations concerning plant operation made by various members of the committee during the year.

The committee also submitted a map showing a tentative line which can be considered an indication of what

*Abstracted in the *Railway Age* of February 13, 1920, page 491, under the report of the American Wood Preservers' Association.

present practices warrant for the division between the use of creosote and zinc treatment for cross-ties. This is a north and south line through the states of North and South Dakota and Nebraska, along the west line of Kansas to Oklahoma, and thence southeasterly to Corpus Christi, Tex.

Conclusions

The committee makes the following recommendations:

For Adoption and Publication in the Manual

(a) Revised Heading for standard specification for creosote oil.

(b) Revised Heading for specifications for tie treatment.

(c) Revised general requirements.

(d) Revised specification for treatment of ties by the Burnettizing process.

(e) Revision of the specification for zinc chloride in the zinc-tannin treatment.

(f) Revised specification for plain creosoting.

(g) Revised specification for zinc-creosote emulsion treatment.

(h) Elimination of the two-injection zinc-creosote treatment.

(i) New specification covering preservative treatment of wood with creosote oil (empty cell process with final vacuum).

(j) New specification covering preservative treatment of wood with creosote oil (empty cell process with initial air and final vacuum).

(k) Directions for the use of the iodine-potassium ferricyanide-starch color reaction test for determining zinc chloride penetration.

Accept as Information

Report on water gas tar.

Report on preservative treatment for Douglas fir.

Paper on the new process for determining the penetration of zinc chloride in wood.

Availability of sodium fluoride.

Committee: C. M. Taylor (P. & R.), chairman; Dr. Hermann von Schrenk (con. engr.), vice-chairman; F. J. Angier (B. & O.), E. H. Bowser (I. C.), Z. M. Briggs (P. L. W.), C. B. Brown (C. N. R), A. S. Butterworth (G. F. & A.), I. A. Cottingham (G. C. L.), W. H. Gardner, Jr., T. H. Gatlin (Sou.), R. H. Howard, W. H. Kirkbride (S. P.), H. Knight (Erie), W. W. Lawson (S. P.), G. E. Rex (A. T. & S. F.), Lowry Smith (N. P.), E. A. Sterling, T. G. Townsend (U. S. R. A.), J. H. Waterman (C. B. & Q.).

Appendix A—Revision of Manual

The committee has revised the specifications covering recommended practices for the different preservative treatments of wood as now appearing in the Manual. The preliminary part of each proposed specification is identical and they are very nearly those specifications as used by all the railroads while under federal control.

The specification which was adopted at the annual meeting in March, 1919, covering preservative treatment of wood with zinc chloride, is changed to have it agree in make-up and procedure with the specifications for use with other preservatives.

The heading "Standard Specification for Creosote Oil," as appearing on page 541 of the Manual, is changed to "Specifications for Grade 1 Creosote Oil." This will provide for three grades of distillate creosote oil, namely, 1, 2 and 3. There are no changes in the specifications for creosote oil this year.

The title "Specifications for Tie Treatment," as now appearing on page 540 of the Manual, is changed to "Specifications for Preservative Treatments."

The General Requirements have been revised, and are as follows:

General Requirements: The General Requirements apply to each of the treatments.

If used in specifications for the purchase of treated material, these General Requirements should be followed by the specification for the particular treatment desired.

Material should not be treated until seasoned. If it arrives at the treating plant in a seasoned condition ready to treat, it may be loaded direct from the cars to the trams; otherwise, it shall be stacked. If ties, they shall be stacked in layers of 1 or 2 and 7 to 10, depending on the width of the ties; if piles or lumber, they shall be stacked to insure even and proper seasoning—with alleys at least three feet wide between rows of stacks extending between tracks, and at least six inches off the ground on treated sills. The space under and between the rows of stacks at all times should be kept free of rotting wood, weeds or rubbish. The yard should be so drained that no water can stand under the stacks, or in their immediate vicinity.

Since the seasoning varies with the latitude, time of year, the exposure and peculiarities of the season, it is essential to establish by experiment the seasoning period usually required to enable each class of timber to best receive treatment. Material piled for seasoning should be closely watched, and not allowed to overseason or to deteriorate. No material should be treated which does not conform to the requirements of the specifications as to shakes, checks, soundness, etc. Material which shows signs of checking should be provided with "S" irons, bolts or other devices, in order to prevent, during or after treatment, further checking that would be liable to render it worthless.

Where ties are to be adzed or bored for subsequent insertion of spikes, or application of tie plates, such adzing and boring should in all cases be done before treatment.

The balance of the General Requirements as given on page 550 of the Manual is eliminated, as the treatment is varied under each specification.

Specification for the Preservative Treatment of Wood with Zinc Chloride

(Substantially the same as U. S. R. A. specification appearing in *Railway Age* for February 21, 1919, page 446.)

This takes the place of "Specifications for the Treatment of Ties by the Burnettizing Process," shown on page 711 in the *Railway Age* for March 20, 1919, and adopted at the March, 1919, meeting of the Association as recommended practice.

Zinc Tannin Treatment: This, as appearing on pages 551 and 552 of the Manual, should stand with the exception that the last paragraph on page 552 down to this quotation—

"The zinc chloride used shall be as free from all impurities of any kind as is practicable, being slightly basic, free from acid, containing not more than 0.25 per cent iron."

is changed to read as follows:

"The zinc chloride used shall be acid-free and shall not contain more than 0.1 per cent iron; fused or solid zinc chloride shall contain 94 per cent soluble zinc chloride; concentrated solution shall contain at least 50 per cent soluble zinc chloride."

The above specification for zinc chloride is the one adopted as recommended practice at the March, 1919, meeting.

On page 552 of the Manual the words "plain creosoting" are changed to read:

Specification for the Preservative Treatment of Wood with Creosote Oil (Full Cell Process)

(Substantially the same as U. S. R. A. specification appearing on page 445 of the *Railway Age* for February 21, 1919.)

On page 553 in the Manual the heading "Zinc Creosote Emulsion Treatment" is changed to—

Specification for the Preservative Treatment of Wood with Zinc Chloride and Creosote Oil

Except when ordered otherwise by the railroad's representative, the material to be treated shall be air-seasoned until in his judgment any moisture in it will not prevent injection of the specified amount of preservative; shall be restricted in any charge to woods into which approximately equal quantities of preserving fluid can be injected; and shall consist of

pieces approximately equal in size and sapwood content, on which all framing, boring, or adzing shall have been done, so separated as to insure contact of steam and preservative with all surfaces.

The zinc chloride used shall be acid-free and shall not contain more than 0.1 per cent iron. Dry zinc chloride shall contain at least 94 per cent soluble zinc chloride, and in any solution purchased the percentage of zinc chloride specified shall be the quantity of zinc chloride required.

The creosote oil shall meet the standard for Grade 3 Creosote oil.

The matetrial shall retain an average of 0.5 pound of dry zinc chloride and 3 pounds of creosote oil per cublic foot, which shall permeate all of the sapwood and as much of the heartwood as practicable, and no charge shall retain less than 90 per cent nor more than 110 per cent of these quantities per cublic foot.

The preserving mixture shall be composed of the volumetric proportions of creosote oil and of zinc chloride solution of the necessary strength which are required to obtain the specified retention of the preservatives with the largest volumetric injection that is practicable, and shall be agitated in the working tank and cylinder so as to insure thorough mixing before and while the cylinder is being filled with preservative and while the preservative is being injected into the material. The strength of the zinc chloride solution shall not exceed 5 per cent and shall be determined by analysis. Chemical titration —using a silver-nitrate solution with potassium-chromate indicator, before the zinc chloride solution is mixed with the creosote oil will usually be satisfactory. For example: With red oak the proportions shall be not less than 77 per cent of 5 per cent zinc-chloride solution and not more than 23 per cent of creosote oil, and the volume injected shall be not less than 20 per cent while with pine having a large percentage of sapwood they shall be not less than 88 per cent of 2.5 per cent zinc-chloride and not more than 12 per cent of creosote oil, and the volume injected shall not be less than 40 per cent. The quantities of preservatives retained shall be calculated from readings of working tank gages or scales and from weights of at least one-tenth of the material on a suitable track scale before and after treatment, checked as may be desired by the railroad's representative.

Air-seasoned material shall be steamed in the cylinder for not less than one hour nor more than two hours, at a pressure of not more than 20 lb. per sq. in., the cylinder being provided with vents to relieve it of stagnant air and insure proper circulation of the steam and being drained to prevent condensate from accumulating in sufficient quantity to reach the material. After steaming is completed, a vacuum of at least 22 inches shall be maintained until the wood is as drv and as free from air as practicable. Before the preservative is introduced the cylinder shall be drained of condensate, and if the vacuum is broken a second one as high as the first shall be created. The preserving mixtures shall be introduced without breaking the vacuum until the cylinder is filled. The pressure shall be gradually raised, and maintained at a minimum of 125 lb. per sq. in. until the required amount of preservatives is injected into the material, or until less than 5 per cent of the total quantity required has been injected during the latter half of one hour throughout which the rate of injection has persistently decreased while the pressure has been held continuously at 165 or more lb. per sq. in. The temperature of the preservative during the pressure period shall be not less than 170 deg. F., nor more than 200 deg. F., and shall average at least 180 deg. F. After the cylinder is emptied of preserving mixture, a vacuum shall be maintained until the material can be removed from the cylinder free of dripping preservative.

At least once each day the railroad's representative shall determine penetration by analysis. The "Iodine-Potassium Ferricyanide Starch" color reaction test to determine the penetration by its visibility will generally be satisfactory. From ties, samples shall be taken at middle and rail sections; from other material samples shall be taken as desired. Any holes that may be bored shall be filled with tight-fitting creosoted plugs.

The treating plant shall be equipped with the thermometers and gages necessary to indicate and record accurately the conditions at all stages during the treatment, and all equipment shall be maintained in condition satisfactory to the railroad. The owner of the treating plant shall also provide and keep in condition for use at all times the apparatus and chemicals necessary for making the analyses and tests required in this specification.

When water gas tar solution instead of creosote is used, it shall meet the following requirements:

The oil shall be a water gas tar product, of which at least 60 per cent shall be distillate of water gas tar and the remainder shall be refined or filtered water gas tar. It shall comply with the following requirements:

1. It shall not contain more than 3 per cent water.
2. It shall not contain more than 2 per cent of matter insoluble in benzol.
3. The specific gravity of the oil at 38/15.5 deg. C. shall not be less than 1.03 nor more than 1.07.
4. The distillate, based on water-free oil, shall be within the following limits:
   Up to 210 deg. C., not more than 8 per cent.
   Up to 235 deg. C., not more than 20 per cent.
   Up to 355 deg. C., not less than 60 per cent.
5. The specific gravity of the fractions between 235 deg. C. and 315 deg. C. shall not be less than 0.98 nor more than 1.02 at 38/15.5 deg. C.
6. The residue above 355 deg. C., if it exceeds 5 per cent, shall have a float test of not more than 50 seconds at 70 deg. C.
7. The oil shall not yield more than 10 per cent coke residue.
8. The foregoing test shall be made in accordance with the standard methods of the American Railway Engineering Association.

When a distillate of water gas tar is used, it shall meet the following requirements:

The oil shall be a distillate of water gas tar. It shall comply with the following requirements:

1. It shall not contain more than 3 per cent of water.
2. It shall not contain more than 0.5 per cent of matter insoluble in benzol.
3. The specific gravity of the oil at 38/15.5 deg. C. shall be not less than 1.02.
4. The distillate, based on water-free oil, shall be within the following limits:
   Up to 210 deg. C., not more than 5 per cent.
   Up to 235 deg. C., not more than 25 per cent.
   Up to 355 deg. C., not less than 80 per cent.
5. The specific gravity of the fractions between 255 deg. C. and 315 deg. C. shall not be less than 0.98 nor more than 1.02 at 38/15.5 deg. C.
6. The residue above 355 deg. C., if it exceeds 5 per cent, shall have a float test of not more than 50 sec. at 70 deg. C.
7. The oil shall not yield more than 2 per cent coke residue.
8. The foregoing tests shall be made in accordance with the standard methods of the American Railwav Engineering Association.

On page 554 of the Manual the "Two-Injection Zinc Creosote" heading and the subsequent specification is eliminated and the following processes substituted:

Specification for the Preservative Treatment of Wood with Creosote Oil (Empty-Cell Process with Final Vacuum)

(Substantially the same as U. S. R. A. specification appearing in the *Railway Age* for February 21, 1919, page 445.)

Specification for the Preservative Treatment of Wood with Creosote Oil (Empty Cell Process With Initial Air and Final Vacuum)

(Substantially the same as U. S. R. A. specification appearing in the *Railway Age* for February 21, 1919, page 446.)

Appendix E—Indicators for Determining the Burnettizing of Ties and Timbers

The committee presented a report on a new indicator for determining the penetration of zinc chloride solutions developed by Galen Wood, chemist of the Port Reading Creosoting Plant, and described in his paper to the American Wood Preservers' Association. A brief synopsis of this appeared in the *Railway Age* for February 13, 1920, page 495.

Directions for the Use of the Iodine-Potassium Ferricyanide Starch Color Reaction Test For Determining Zinc Chloride Penetration

This method requires the following chemicals and apparatus:

1. Potassium ferricyanide.
2. Potassium iodide.
3. Soluble starch.
4. Atomizer.

The chemicals should be purchased chemically pure and half pound each should be enough for any plant at one time. De Vilbiss Atomizer No. 30 is very satisfactory.

For stock solutions of the three chemicals make 200 cc each to be kept separately until used:

1. 1 per cent potassium ferricyanide. (2 gm. dissolved in 200 cc water.)
2. 1 per cent potassium iodide. (2 gm. dissolved in 200 cc water.)
3. 5 per cent soluble starch. (10 gm. dissolved in 200 cc water.)

Mix the weighed starch with a little of the measured cold water and then pour into the remaining water boiling hot and continue to boil until the starch is in solution. Starch solution will not keep for many days and must not be used when it begins to sour.

To make a test for zinc chloride penetration, simply pour 10 cc each (or equal amounts) of the three stock solutions into atomizer and spray the cross section of the tie evenly all over; if zinc chloride is present a deep blue stain will result showing clearly the depth of penetration.

Appendix F—Availability and Use of Sodium Fluoride as a Preservative for Cross-ties

Sodium fluoride as a preservative for cross-ties could be made available in large quantities if an assured market could he had for the product. It may be prepared as a direct product, or it may be had from discarded by-products of fertilizer plants using phosphate rock.

The committee had nothing new to report in connection with this preservative. On account of the increasing cost of creosote oil, the merits of sodium fluoride, as well as those of other preservatives, should be investigated further with the view of obtaining an ample supply of satisfactory wood preservatives at a moderate cost.

Appendix G—Creosote Treatment to Be Used in the Protection of Piles and Timbers in Teredo-infested Water, Specifying Amount of Creosote to Be Used

The committee has investigated generally the conditions and present practices of the various railroads having terminals in marine waters, and the results of these investigations have shown the matter to be so complex that the committee is not able to report on a recommended treatment. The investigations to date, however, indicate that a borer known as "Sphaeroma" has become better known and whose damage is less often mistaken for that of the teredo. It seems to work in brackish and salt waters, and while its action is slow the results are certain, and those railroads which have bridges or structures in waters adjacent to salt water should investigate to determine whether this form of wood-boring organism is present.

Appendix H—Comparative Values of Grades 1, 2 and 3 Creosote Oil and Creosote-Coal-Tar Solutions as Preservative Agencies

Grade 1 is considered to give us the best grade of creosote oil in so far as we are able to judge it at the present time.

Grades 2 and 3 are more volatile and their use is not expected to insure the factor of safety to be had from the use of grade 1, except that a larger quantity of grades 2 or 3 would probably give the same results as a smaller quantity of grade 1.

The preservative treatment of ties in recent years has developed that they should not only be treated to prevent decay, but also that there should be a component in the oil that will aid in preventing the surface checking and subsequent minor splitting of the tie, and the committee feels that the creosote-coal-tar solution, if in strict accordance with the specification of this Association, will both preserve the tie from decay and will in a large measure help in the prevention of this surface checking.

Appendix I—Notes on Existing Conditions at Some Treating Plants

We find that the handling of the preservative treatment and the direct operation of the wood-preserving plants of the various railroads is supervised in many cases by departments that have small conception of the engineering features of wood preservation, or the importance of properly treating the material.

There are treating plants now operated whose main object is quantity production. Some plants are even operating their treating cylinders on a time table basis. Furthermore, there seems to be a decided lack of knowledge as to when the material is fit for treatment or as to when it is decayed and consequently should never be treated.

Furthermore, the committee has found treating plants that keep no records of the treatment which the material receives; that have no gages to record the varying temperatures that exist in the treating cylinders; where those in charge have slight conception of the actual treatment which the material is receiving because they never weigh a charge; nor do they even take the trouble of making cross sections, or taking increment borings of any material after treatment; nor do they apparently attempt to improve the treating equipment.

Discussion

C. M. Taylor (chairman): There has been a constant demand for several years for standard specifications for material to be treated. We have had them in the Manual, and they should have been revised some years ago. This last year seemed an opportune time to get all of our revisions properly made, and the committee in charge of revision of the Manual has given a report.

The first point brought out is that the heading "Standard Specifications for Creosote Oil" be changed to "Specifications for Grade 1 Creosote Oil," the idea being that we have practically four different kinds of creosote oil and that we should have them graded so that they can be easily understood. There is no change in the specifications other than the heading. I move that the heading of the specifications be changed to read "Specifications for Grade 1 Creosote Oil."

(Motion seconded and carried.)

The chairman: Practically all timber has to be in the same condition to be treated by the different processes, so that the question of general requirements for all treatments is and should be approximately the same. The committee therefore offers a revision of the general requirements. I move that the revision covered under "General Requirements" be adopted as recommended practice.

(Motion seconded and carried.)

The chairman: I have overlooked one item, "Specifications for Preservative Treatments." We have always had specifications for tie treatment. As I said before, the specifications for all preserving treatments cover ties and other materials. I should like to have the title "Specifications for Tie Treatment" changed to "Specifications for Preservative Treatments." I make that as a motion.

(Motion seconded and carried.)

The chairman: The next is "Specification for the Preservative Treatment of Wood with Zinc Chloride," and starting out on this revision of specifications for different treatments we have lined them up all in the same rotation as to procedure. That is in line with the fact that all timber has to be in the same general condition for all the different treatments. The specification for the pre-

servative treatment of wood with zinc chloride is one that has been in use for a considerable length of time.

I move that the specification be inserted in the Manual as recommended practice.

(Motion seconded and carried.)

The chairman: The next item is the "Specification for the Preservative Treatment of Wood with Zinc Chloride and Creosote Oil." That is the combined process which is being used considerably by several of the railroads. In view of the fact that to use this process it is generally necesary to have the consent of the patentee, it will be necessary to so show it. The specification as given should be used in conjunction with one or two patents, namely, U. S. patent 815404, granted in 1896, and another patent granted in April, 1916, No. 1,178,132, so as to make it absolutely clear that the process covered here is possibly covered by a patent.

The next is "Specification for the Preservative Treatment of Wood with Creosote Oil." That is also covered —not covered possibly, but it is used in conjunction with the patent issued in September, 1906, No. 831450. The next is the empty cell process with initial air and final vacuum. This was covered by patent No. 707789, but that expired last September, and it is now free to everyone. I move the adoption of these specifications for recommended practice.

(Motion was seconded and carried.)

The chairman: The question of service records is one that is becoming more and more important in connection with timber preservation. Each year we have further examples of the good work and the financial saving that have come through timber preservation, and this year we have a report that was gotten out in connection with the tie committee of this association and the Wood Preservers' Association, covering work on the Delaware, Lackawanna & Western and the results.

Dr. Herman von Schrenk (vice-chairman): In the past we have given tabulated statements in a rather condensed form taken from the records of various lines. This year we are establishing a system of giving more detail in available records on an individual railroad, and we started out with the Lackawanna, because of the very excellent type of record which it has kept from the very start of its tie treating. One of the great difficulties in the history of treated ties has been the lack of definite information concerning what may be reasonably expected from their use.

Fred Lavis (Am. Int. Co.): I would like to ask one question about the Lackawanna record. The decreased number of ties renewed seems to be very marked since 1915. Does the committee know whether this is due entirely to the use of treated ties, or whether it may be due to other causes, such as the war, increased cost and action of the Railroad Administration?

The chairman: I feel that we are not in a position to say, but my understanding is that the decrease is largely due to the good work that the road has done in preservation, so that it does not therefore have to put in as many ties as it did previously.

Hunter McDonald (N. C. & St. L.): I would like to ask Dr. von Schrenk if he has any information which would explain the results gotten from untreated ties which seem to be remarkable.

Dr. von Schrenk: Most of the untreated ties are chestnut.

Mr. McDonald: They must have had very heavy tie plates.

Dr. von Schrenk: Yes, most of them were on the side lines and side tracks. You see, all tracks are included in this report.

The chairman: Appendix C, Water Gas Tar, is submitted for information. Referring to Appendix D, the preservative treatment of Douglas fir is one that is not so clear, but we hope during the coming year to be able to work up a treatment that will give excellent results.

The next is Appendix E, "Indicators for Determining the Burnettizing of Ties and Timbers." This is a paper borrowed from the Wood Preservers' Association, showing a new method for determining the penetration of zinc chloride. I move that the directions given be placed in our Manual as recommended practice for determining zinc chloride penetration.

(Motion seconded and carried.)

The chairman: Appendix F. With the increasing prices, due to the scarcity of creosote oil, and the rise in price of zinc chloride, other preservatives are being pushed for the same class of work as these two preservatives have filled in the past. Sodium chloride, which is new to the majority of you, is coming before you as a new preservative. The indications are that it will rival zinc chloride, and perhaps be a better preservative in places where zinc chloride has been used in the past. The Philadelphia & Reading Coal & Iron Co. are using it exclusively in the treatment of their mine props and are getting excellent results. There is a question whether it does not have less effect on the track circuits than zinc chloride that will undoubtedly be handled this coming year. Appendix F is submitted as information.

Last on the program is Appendix G, presenting a new subject started last year. We are fortunate in having on our committee several men who are located along the coast line, and the territory was divided into three divisions, Pacific, Atlantic and Gulf territories. This work was in charge of Dr. von Schrenk, the vice-chairman, who will present it.

Dr. von Schrenk then briefly discussed the work of the territorial subcommittees, after which Lowry Smith (N. P.) presented some lantern slides showing the destructive effect of the marine borers. Following a short discussion of these slides, the committee was dismissed with thanks.

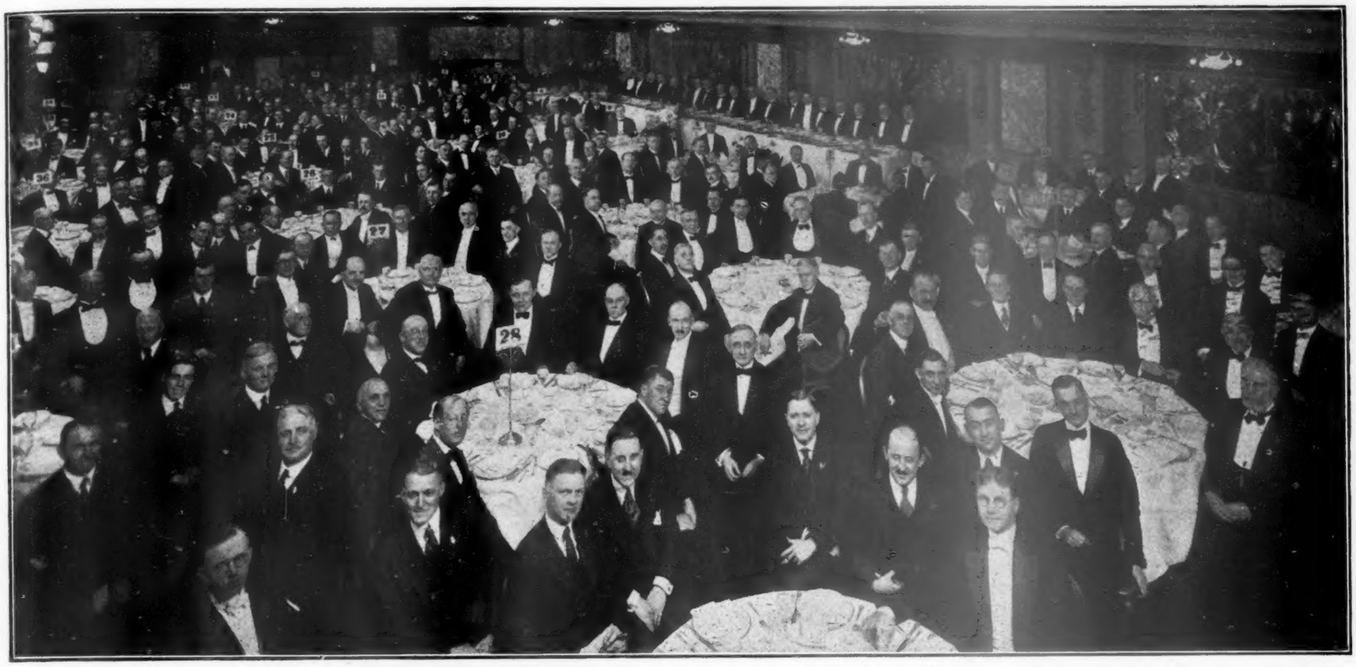
Request Made for Formation of New Sectional Committee

A request has been made of the Signal division by signalmen located around and near Livingston, Mont., for the formation of a new sectional committee to be known as the Livingston Sectional Committee. The formation of such a committee would permit more signalmen to attend these meetings than can do so at present, when it is necessary for them to either attend the St. Paul Sectional Committee meetings or the Tacoma Sectional Committee meetings. By forming a sectional committee at Livingston, the mileage between St. Paul and Tacoma would thus be divided, as this place is approximately midway between these two cities.

The Committee on Direction approved the application for the formation of this new sectional committee at its meeting yesterday.

J. B. Jenkins Promoted to Lieut.-Colonel

J. B. Jenkins, valuation engineer of the Baltimore & Ohio and for a number of years chairman of the Track committee of the American Railway Engineering Association, was promoted from major to lieutenant-colonel in the Engineering Reserve Corps on January 3, 1920. Mr. Jenkins was recommended for this promotion before the signing of the armistice, but its confirmation was delayed in common with all other similar recommendations.



Banquet of the American Railway Engineering Association Last Evening

The Dinner of the Engineering Association

Abstracts of Two Addresses Presented at the Twenty-First Annual Banquet Held Last Evening

THE TWENTY-FIRST ANNUAL DINNER of the American Railway Engineering Association was held last evening in the Gold Room of the Congress Hotel. President Earl Stimson presided, as he did last year, in the absence of President C. A. Morse. The speakers of the evening were Dr. Winthrop Ellsworth Stone, president of Purdue University, LaFayette, Ind., and Hon. and Rev. Henry J. Cody, M.A., D.D., LL.D., member of the Ontario legislature and former minister of education of Ontario, Toronto, Ont.

"The College and the Industries"

Dr. Stone, in speaking on this subject, said in part: The college man is a useful man. When he is assigned to a task he acquits himself like a man. If you are to take the young college graduate, put him into industry, and compare him with the type of young man who in early life has been thrown out on his own resources, and has made his way in practical affairs, and taken the hard knocks of life, the comparison will be to the disadvantage of the young college graduate. But while this other boy has been getting hard knocks, the college boy has been getting training, and he, too, will come in for his share of the hard knocks; and when he has combined that double treatment of training and experience, he becomes a man who, other things being equal, will, I think, surpass the merely practical man.

The college graduate rather reflects the general social condition and public sentiment. The college is not responsible for his birth and his bringing up, and his inherited qualities. About all the college can do is to take him for a brief time, try to train him in some specific things, and try to develop in him a kind of character.

When industry takes hold of this young man it expects a great deal of him. Industry needs trained men more than ever before in the history of the world. Industry as it advances becomes more and more complicated, competition becomes greater, and depends more and more upon the technically trained man and the scientist.

And the source of these trained men, these scientific men, who are to assist industry, must be in the colleges and in the universities. In the railway field particularly the suspension of development and construction work on the railroads has taken away from many of our engineering graduates the opportunities for employment, and they, recognizing this, are going into other fields, and particularly the civil engineers, who might otherwise expect to go into railway work, do not find there now the openings they used to find, and through force of circumstances they are going off into other fields.

Engineering graduates in general we find are less and less attracted to real engineering work, and are more inclined to go into the sales departments of engineering, for the very obvious reason that it offers them larger compensation.

Now, that is true not only of engineers, but it is true of every class of young men who are training themselves for scientific and technical engineering pursuits. They find that the rewards of these pursuits are less than the rewards for many other things, and the result is, that while we have a good many students coming in for training in engineering when they get through they do not persist in the engineering field, and that is bad for industry and bad for engineering, because we need them in all capacities and all branches, and I venture to say that there is not much danger of our having too many trained men in any industry.

America potentially has a great future before it. That is even greater now than ever before. I think we feel that the things that have come out of this war and the position in which America finds itself, opens up before it a limitless vision of greatness, and yet at the same time America stands today probably in greater danger

than ever before, and one of the things that threatens it is the habit which is forming among our men of giving their best energies to the making and spending of money.

Education in Reconstruction

Henry J. Cody, the second speaker, referred briefly to the recent period of government control in this country and the return of the roads to private control and then took up the case of the Canadian roads, saying in part:

"We in Canada are engaged in a somewhat similar experiment. Some of our great railways are being put under government control, but the railroads will be managed by a non-political, non-partisan commission. We hope the result of their operation will be successful. Over against them stands another great railway system under private control, a system that has been very successful in the past and very enterprising. I imagine that the competition of the state system and the privately owned system will possibly be good for both, and I trust that both will be good for the country. I trust they will not charge all that the traffic will stand. That seems to be one of the sublime secrets of railway administration. Evidently it is necessary, if you are to keep your rolling stock and road-beds in good condition.

"In Canada at the present time we are, with you, facing some of the most serious problems of reconstruction, and I thought I might venture to say something to you tonight upon one of those problems common to you and to ourselves."

Following this, Rev. Cody took up the problems of reconstruction with special reference to the factor of education. This was solved in large part, he said, by appealing to qualities of courage, unselfishness, loyalty and responsibility developed in the trials of the war. He closed with an appeal for united action to make future wars impossible through support of the League of Nations.

Further Comment on the Dinner

The profound success of the association's banquet cannot be ascribed entirely to the flood of eloquence, logic, wit and harmony which characterized the program following the repast. The dinner of itself was no mere detail of the arrangement for an evening's enjoyment. In fact, we dare say it played an even more important part than the spiritual and mental feast which followed. The menu was notable for its excellence, variety and abundance. In fact, the dinner was such a complete gastronomic success in every way that we feel impelled to make a permanent record of the menu by reproducing it in full below:

MENU

Blue Points — Celery

Sherry

Consomme Royal

Radishes — Pim-olas

Salted Almonds

Filet of Sole, Normande

Cucumbers — Persillade Potatoes

Sauterne

Ballotine of Chicken — Maryland Sauce

Asparagus Tips

Tenderloin of Beef, Larded, Marechale — Green Peas

Claret

Punch Cardinal

Roast Golden Plover, on Toast — Lettuce Salad

Neapolitan Ice Cream — Assorted Cakes

Camembert — Coffee

Cigars

To avoid any possibility of confusion on the part of those who attended last evening's dinner, it suffices to say that the remarks and tabular matter presented above concern an entirely different affair, namely, the *first* annual banquet of the American Railway Engineering and Maintenance of Way Association, held in the main dining room of the Victoria Hotel, Van Buren street and Michigan avenue, Chicago, on March 15, 1900, when 200 members and friends of the association spent a pleasant evening under the able direction of President John F. Wallace. Shades of John Barleycorn and the full dinner pail. "Them was happy days!"

Memories

DEDICATED TO E. H. F.

1.

I remember, I remember,
In the days of long ago,
When there was no 'Sociation,
Such as today we know.
Augustus Torrey and L. C. Fritch,
Were present at its birth.
One was guilty, I don't know which,
Each was of equal worth.

2.

I remember, I remember,
When discussion was not barred,
Whether "Cluster" was a proper
Designation for a yard,
Was discussed for one whole session,
By such men as Sullivan,
Wilson, Hatch, Torrey, Mountain,
And the "Mac's" of every clan.

3.

Cheney, Church, Dickson and Bremner,
Dougherty, Kinnear and Duane,
Paradis, Curtis, Rodd and Taylor,
Memories that will not wane;
Lum, Carrothers, Berg and Trimble,
Hudson, Bates and Peterson,
Wallace, Mordecai and Churchill,
All donated to the fun.

4.

Rockwell, Berry, Montfort, Breckenridge,
Whittlesey, Whittemore and Handy,
Garrett, Darling, Dun and Kittredge,
On the railroads made their way.
Willard, Kruttschnitt, Harahan, Felton,
Elliott, Delano and Beeler,
Kelley, Underwood and Johnson,
Filled the presidential chair.

5.

Isaacs, Modjeski and Morison,
In the field of specialists,
Schneider, Bontscou, Bouscaren,
Are the names that head the lists,
Pence and Allen, Prout and Tratman,
Camp and Crandall, Swain, Turneaure,
Were the editors and teachers,
Who were faithful every year.

6.

See the list of Charter Members,
Scan it closely, mark it well.
Gone are many each remembers,
Where? No mortal man can tell;
Note the jobs those still among us
Had, the places they now fill,
And take heart, renew your purpose,
To like them fulfill the bill.

C. E. L.

The A. R. E. A. Elects New Officers

Results of Annual Election Announced Yesterday; Sketch of President-Elect H. R. Safford

SHORTLY BEFORE THE CLOSE of the afternoon session yesterday, Secretary Fritch announced the results of the balloting for officers for the ensuing year. The election resulted as follows:

President, H. R. Safford, assistant to president, Chicago, Burlington & Quincy, Chicago.

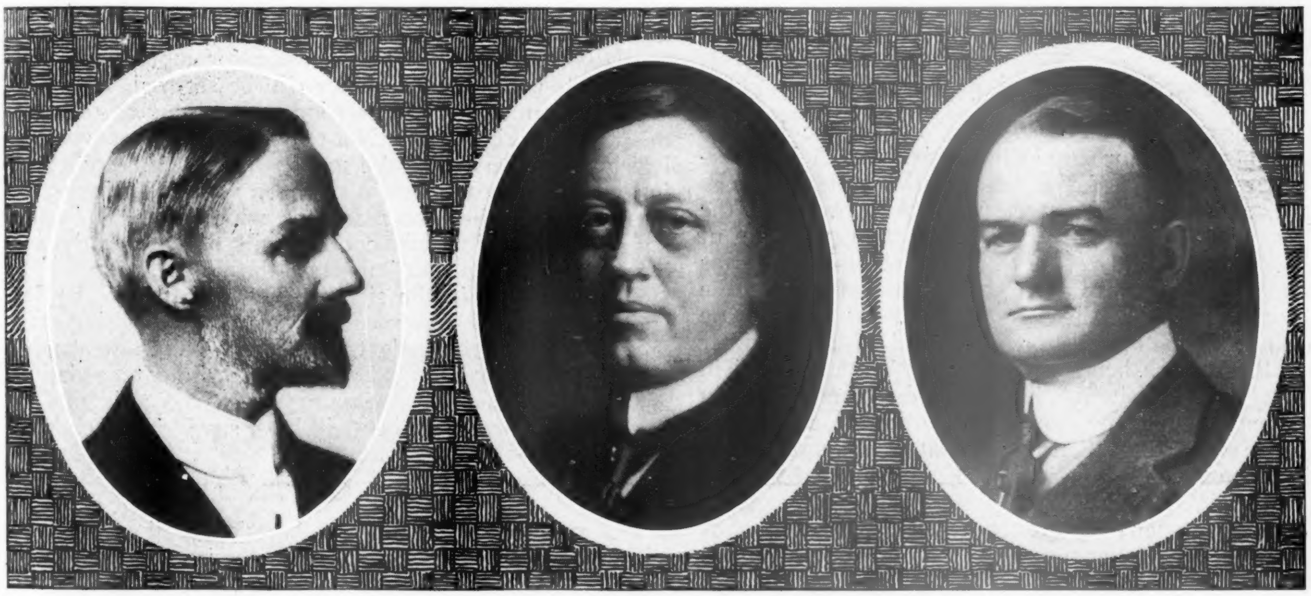
Vice-president, L. A. Downs, vice-president and general manager, Central Railroad of Georgia, Savannah, Ga.

Treasurer, G. H. Bremner, district engineer, Interstate Commerce Commission, Chicago.

Secretary, E. H. Fritch, Chicago.

Directors: Edwin B. Katte, chief engineer electric traction, New York Central, New York City; J. M. R. Fairbairn, chief engineer, Canadian Pacific, Montreal, Que.; F. E. Turneaure, dean, College of Engineering, University of Wisconsin, Madison, Wis.

Members Nominating Committee: A. W. Newton, chief engineer, Chicago, Burlington & Quincy, Chicago; R. S. Parsons, general manager, Erie, New York City; H. T. Douglas, Jr., chief engineer, Chicago & Alton, Chicago; Maurice Coburn, supervising engineer, Pennsylvania Railroad, Indianapolis, Ind.; W. P. Wiltsee, principal assistant engineer, Norfolk & Western, Roanoke, Va.



J. A. Atwood
First Vice-President

H. R. Safford
President

L. A. Downs
Second Vice-President

Officers-Elect of the A. R. E. A.

H. R. Safford, President-Elect

When H. R. Safford was selected by the nominating committee as candidate for second vice-president of the American Railway Engineering Association, that well-meaning body undoubtedly intended that his elevation to the presiding office of the association would afford the Canadian members their periodic representation among the presidents. Circumstances, however, have defeated this laudable aim, since Mr. Safford subsequently returned to the United States as an officer of the United States Railroad Administration and is now permanently established in this country as assistant to the president of the Chicago, Burlington & Quincy. In spite of this unintentioned favor to the membership south of the international boundary, the many friends which Mr. Safford acquired during his eight years' residence in Montreal will still feel that he represents them in spite of his residence in Chicago and the fact that he is a native-born American. It is one of the odd coincidences of life that the responsibility for Mr. Safford's going to Canada falls on Howard G. Kelley, one of the early presidents of this association, who was at that time vice-president of the Grand Trunk.

Like a number of his predecessors, the newest president of the association has grown beyond the limitations of a chief engineership, for as assistant to the president of the Chicago, Burlington & Quincy, the Colorado & Southern and the Ft. Worth & Denver City, he occupies what is more than an engineering position. His ability to grasp the broader phases of railway transportation is partially the result of his natural makeup and partially the consequence of his training. He is a product of the Illinois Central engineering department, which has probably produced more operating and executive railway officers than that of any other strictly western roads. Another evidence of his general breadth of character is evidenced by his selection as one of seven members at large on the Development Committee of the American Society of Civil Engineers.

Mr. Safford possesses more than ordinary ability to inspire quickly confidence and respect. When in September, 1918, he joined the staff of the Central Western region of the United States Railroad Administration, he was virtually a stranger to Hale Holden, regional director. Consequently, the considerations which prompted Mr. Holden to select his engineering assistant for an important position in the Burlington organization were based entirely on the impressions gained during the time that Mr. Safford was with the Central Western region, a large part of which he spent away from headquarters.

Harry Robinson Safford was born at Madison, Indiana. Being a Hoosier, it was but natural that he should

attend Purdue University, from which he graduated in 1895, entering railway service the same year as a rodman with the Illinois Central. He was promoted to resident engineer in charge of construction in 1897 and to roadmaster in 1900. In May, 1903, he became principal assistant engineer and from 1905 to 1906 he was assistant chief engineer, being promoted in the latter year to chief engineer maintenance of way and remaining in this position until May, 1910, when he resigned to become assistant to the president of the Edgar Allen American Manganese Steel Company. He resigned this position in October, 1911, to become chief engineer of the Grand Trunk, which position he held until appointed engineering assistant under the United States Railroad Administration.

Mr. Safford has given freely of his time to association matters and has long been considered a source of strength in association affairs. While his acquaintances are unanimous in agreeing that his selection for president should accrue greatly to the advantage of the association, the fact that he is built on generous and well-proportioned lines leads his intimate friends to the conclusion that he should be an ornamental as well as useful leader of the association, although this idea is not readily reconciled with the reluctance with which he parts with photographs to be used for publication purposes.

Purdue Alumni Luncheon

The Chicago Alumni Association of Purdue University held a special luncheon at the University Club yesterday noon in honor of the new president-elect, H. R. Safford, and vice-president elect, L. A. Downs, of the American Railway Engineering Association, who are of the classes of '95 and '94 of Purdue University. It was voted at the luncheon to make this an annual affair to be held during the A. R. E. A. convention for the purpose of getting Purdue men better acquainted with each other and with the work being accomplished by the alumni in different fields of industry. Fifty-nine men were in attendance; among those present were: W. D. Pence, member Engineering Board, Interstate Commerce Commission, Bureau of Valuation; C. C. Albright of Purdue University; W. K. Howe, chief engineer, General Railway Signal Company; W. K. Hatt, head of the school of Civil Engineering, Purdue University; H. R. Safford, assistant to the president, Chicago, Burlington & Quincy; G. W. Hand, assistant to the president, Chicago & North Western; Dr. Stone, president, Purdue University; E. W. Kolb, signal engineer, Buffalo, Rochester & Pittsburgh; and C. H. Tillett, signal engineer, Grand Trunk.

Representative railroad men were present from the Chicago, Burlington & Quincy; the Pennsylvania; the Chicago & North Western; the Chicago, Milwaukee & St. Paul; the Grand Trunk; the Buffalo, Rochester & Pittsburgh; the Baltimore & Ohio; the Detroit, Toledo & Ironton, and the Central of Georgia.

Short addresses were made by Mr. Safford, Dr. Stone, Mr. Hatt, Mr. Howe, Mr. Pence, Mr. Albright and Mr. Brady of the Illinois Steel Company.

Dr. Stone spoke of the great problem faced by the university with reference to its activities in educational work and of the manner in which the ex-students have loyally stood by the university. Mr. Hatt spoke of the new education problems confronting engineers and of the necessity for a broader training for them in order to better fit them for handling the more complicated situations that are being presented to engineers for solution under the present industrial conditions. He also pointed out the enlarged opportunities for engineers in the new order which is coming to pass.

Signals Relieve Traffic Congestion

The extension of block signaling and of interlocking offers a natural and most ready solution of the problem of traffic congestion under which the roads are now struggling, in the opinion of J. C. Mock, signal engineer of the Michigan Central, expressed to a representative of the *Daily Railway Age* yesterday. The roads have been endeavoring to handle a traffic which has taxed their ability to the limit for several months and the demand for increased capacity is most urgent. Any considerable increase in facilities will require time and the expenditure of large funds which are not now available. Therefore it is the opinion of Mr. Mock that the near future will see a large extension of signaling. Those roads which were less thoroughly equipped with signals at the beginning of the period of federal control will undoubtedly be the first to come into the market. The changing of older signal systems to upper quadrants or light signals which was discontinued temporarily during the war will undoubtedly be undertaken with renewed speed.

Mr. Mock further went on to say that one of the first general objectives of signaling is the arrangement of sidings in such positions that the switches may be handled readily to avoid delays to traffic. If all trains can be kept moving, or, failing that, if some can be diverted onto sidings to keep the main tracks clear for more important traffic, the maximum efficiency will be secured.

The recent railway legislation contains much of optimism for the signal man. Not only will the more favorable legislation under which the roads will operate be reflected in the signal department in common with other branches of the service, but the reference which is made in the law to automatic train control will direct greatly increased interest to that important development.

There is work in the signal field which cannot be delayed. There are improvements which are awaiting only the authority of the budget. When all or any great portion of the signaling and interlocking in contemplation and of economic advantage to the railways is put in hand, the note of optimism will have swelled to a chorus.

He Got the Order

The resourcefulness of the American railway supply salesman is well illustrated by methods adopted by J. E. Bachelder, manager of the marine engine and pump department of Fairbanks, Morse & Company, Chicago, in landing an order in the West Indies recently. He was in New York when he learned that a large contract for engines and other equipment was about to be let by a firm in Nassau, British West Indies. He found that no boat was scheduled to sail in time for him to reach that city in advance of the letting. He went to Miami, Fla., and endeavored to catch a boat from that point, but learned that because of a strike there was again no prospect of his being able to secure steamer accommodations in time. He therefore, made the trip of 150 miles by hydroplane. He got the order.

Michigan Central Attendance

The Michigan Central engineering department is represented at the convention by Colonel George H. Webb, chief engineer; A. J. Deimling, assistant chief engineer; Hans Ibsen, bridge engineer, and other system officers, as well as 56 officers and foremen from various divisions east and north of Chicago. This large attendance is in line with the general policy of the company to encourage its men to obtain first-hand knowledge of the instructive exhibits of the National Railway Appliances Association.

A. R. E. A. Registration

A TOTAL OF 129 MEMBERS of the American Railway Engineering Association and 55 guests registered at the convention yesterday. Including the registration on Tuesday, this gives an aggregate of 540 members and 178 guests, the largest for the first two days in any year.

Members

Allen, Andrews, consulting engineer, Chicago.
Allen, L. B., Eng. M. W., C. & O., Huntington, W. Va.
Anderson, Anton, Eng. M. W., Chicago, Ind. & Louisville, Lafayette.
Austill, H., Bridge Engineer, M. & O., Mobile, Ala.
Bachelder, F. J., Consulting Engineer, Chicago, Ill.
Baldwin, Hadley (Director), Asst. Ch. Eng., C. C. C. & St. L., Cincinnati, O.
Banks, T. G., Dist. Eng. M. K. & T., Oklahoma City, Okla.
Bates, F. E., Asst. Bridge Eng., Mo. Pac., St. Louis, Mo.
Blaess, A. F., Engineer M. W., I. C., Chicago. Ill.
Bragg, R. R., Division Engineer, C. R. I. & P., Dalhart, Texas.
Boardman, Francis, Div. Eng., Elec. Div., N. Y. C., New York, N. Y.
Bowser, E. H., Supt., Timber Dept., I. C., Memphis, Tenn.
Brown, H. W., Div. Eng., Penn. Lines, Cleveland, Ohio.
Campbell, H. A., Engr. Auditor, C. M. & St. P., Chicago.
Carpenter, H. R., Asst. Chief Engineer, M. P., St. Louis, Mo.
Cassil, H. A., Eng. M. of Way, P. M., Detroit, Mich.
Cheney, B. M., Gen. Insp. Per. Way, C. B. & Q., Chicago.
Cronican, W. P., Chief Draughtsman, Illinois Central, Chicago.
Cunningham, A. O., Chief Engineer, Wabash, St. Louis, Mo.
Dalstrom, O. F., Eng. of Bridges, C. & N. W., Chicago.
Daniels, Arthur, Dist. Eng., C. M. & St. P., Minneapolis, Minn.
Dawley, W. M., Asst. Eng., Erie, New York.
Dawley, W. S., Consulting Engr., St. Louis, Mo.
Deimling, J. F., Asst. Ch. Eng., M. C., Detroit, Mich.
Desmond, J. J., Roadmaster, I. C., McComb, Miss.
Dewees, A. R., Div. Eng., P. M., Saginaw, Mich.
Edwards, J. H., Am. Bridge Co., New York City.
Edwards, W. R., Sen. St. Eng., I. C. C., Washington, D. C.
Ehrke, John, Supt. Grand Trunk, Battle Creek, Mich.
Fairchild, Dennison, Supvr. B. & B., Nor. Pac., Duluth, Minn.
Fatherson, T. W., Eng. M. W., C. G. W., Des Moines, Iowa.
Fitzpatrick, P. D., Ch. Eng., Central Vermont, St. Albans, Vt.
Flora, G., Insp. Track Val., Grand Trunk, Durand, Mich.
Garner, R. D., Eng. Const., S. N. E., Providence, R. I.
Glass, R. G., Asst. Insp. Eng., Ill. Steel Co., Chicago, Ill.
Graham, F. M., Eng. M. of W., Penna., Columbus, Ohio.
Hadley, E. A., Ch. Eng., Mo. Pac., St. Louis, Mo.
Hallsted, R. H., Gen. Roadmaster, Mo. Pac., Coffeyville, Kan.
Hamilton, H. F., Dist. Eng., G. N., St. Paul, Minn.
Hansen, H. J., Office Eng., C. M. & St. P., Chicago.
Harman, H. H., Eng. Bridges, B. & L. E., Greenville, Pa.
Harris, G. H., Special Eng., Mich. Cen., Detroit, Mich.
Harris, L. G., Div. Eng., A. T. & S. F., San Marcial, N. M.
Harting, O. F., Asst. Ch. Eng., St. L.-E. St. Louis Term. Dist., St. Louis, Mo.
Hayward, G. I., Asst. Dist. Eng., Northern Pac., St. Paul, Minn.
Heidenthal, W. C., Eng. M. W., N. Y. O. & W., Middletown, N. Y.
Heimerdinger, W. E., Asst. Eng., C. R. I. & P., Des Moines, Ia.
Herth, C. E., Div. Eng., B. & O., Seymour, Ind.
Hinman, Dean, Asst. Eng., C. & G. W., Chicago.
Hopkins, A. T., Asst. Val. Eng., M. C., Detroit, Mich.
Howard, R. H., Chief Eng. M. W., Wabash, St. Louis, Mo.
Huntsman, F. C., Asst. Eng., Wabash, Springfield, Ill.
Johnson, J. M., Con. Eng., Ill. Cent., Louisville, Ky.
Johnston, C. E., Gen. Man., K. C. S., Kansas City, Mo.
Johnston, D. B., Div. Eng., Pa. Lines, Louisville, Ky.
Johntz, H. H., Eng. M. W., M. K. & T., Parsons, Kan.
Keough, R. E., Asst. Eng. M. W., C. P., Montreal, Canada.
Kern, J. W., Jr., Roadmaster, I. C., Water Valley, Miss.
Kinney, W. M., Gen. Man., Portland Cement Assn., Chicago.
Kinsley, T. W., Asst. Eng., D. T. & Ironton, Springfield, Ill.
Knecht, H. D., Asst. Eng., Mo. Pac., St. Louis, Mo.
Knight, H., Regional Engineer, Erie, Youngstown, O.
Koyl, C. H., Eng. Water Service, C. M. & St. P., Chicago.
Lakin, F. D., Div. Eng., Erie, Meadville, Pa.
Lang, P. G., Jr., Asst. Eng. of Bridges, B. & O., Baltimore, Md.
Layng, F. R., Eng. Track, B. & L. E., Greenville, Pa.
Livingston, H. T., Div. Eng., C. R. I. & P., Manly, Ia.
Maher, John, Asst. Eng., B. & O., Cincinnati, Ohio.
McCooe, David, Supt. of Track, G. T., Toronto, Ont., Can.
Meigs, M. C., Asst. Eng., Y. & M. V., Memphis, Tenn.
Middleton, R. J., Asst. Chief Eng., C. M. & St. P., Seattle, Wash.
Miner, K. L., Supv. B. & B., N. Y. C., Ottawa, Ont., Canada.
Mitchell, W. M., Louisville Frog & Switch Co., Louisville, Ky.
Moore, J. W., Asst. Eng., Val. Dept., I. C., Chicago.
Morrow, F. E., Ch. Eng., C. & W. I., Chicago.
Mottier, C. H., Off. Eng., I. C., Chicago.
Mullen, Joseph, St. Louis, Mo.
Myers, J. B., Eng. M. W., B. & O., Baltimore, Md.
Newton, A. W., Chief Engineer, C. B. & Q. Chicago, Ill.
Nichols, J. A., Jr., Asst. Eng., C. C. C. & St. L., Mattoon, Ill.
O'Rourke, G. M., Roadmaster, I. C., Mattoon, Ill.
Oxnard, H. W., Pilot Engr., Santa Fe, Topeka, Kan.
Passel, H. S., Chief Eng., C. I. & W., Indianapolis, Ind.
Pfafflin, E. H., Ch. Eng., C. T. H. & S. E., Chicago, Ill.
Pfleging, F. W., Sig. Eng., U. P., Omaha, Neb.
Podmore, J. M., Div. Eng., N. Y. C., Toledo, Ohio.
Ramsey, F. R., Chief Eng., T. St. L. & W., Frankfort, Ind.
Ray, W. M., Asst. Eng., B. & O., Pittsburgh, Pa.
Raymond, W. G., Dean, Col. Appl. Sc., State Univ. Iowa, Iowa City, Iowa.
Rist, C. J., Div. Eng., P. M., Saginaw, Mich.
Rohbock, W. L., Chief Eng., W. & L. E., Cleveland, Ohio.
Roof, W. R., Bridge Eng., Chicago Great Western, Chicago.
Sessions, O. H., Div. Engr., G. T., Battle Creek, Mich.
Sexton, J. R., Reg. Eng., Erie, Chicago.
Shaw, B. B., Div. Eng., C. R. I. & P., Little Rock, Ark.
Shaw, W. J., Jr., Div. Eng., M. C., St. Thomas, Ont., Can.
Snyder, J. A., Roadmaster, M. C., Jackson, Mich.
Spencer, C. H., District Eng., Bureau Val., I. C. C., Washington, D. C.
Stevens, W. C., Asst. Eng., C. C. C. & St. L., Mattoon, Ill.
Stimson, F. J., Ch. Eng. Maint., S. W. System, Penna. Lines, St. Louis, Mo.
Swisher, H. H., Asst. Eng., C. M. & St. P., Chicago, Ill.
Thompson, W. S., Div. Eng., Penna., Sunbury, Pa.
Turneaure, F. E., Dean, Col. of Engr., Univ. of Wis., Madison, Wis.
Turner, W. G., Asst. Eng., Mo. Pac., St. Louis, Mo.
Tuthill, G. C., Br. Eng., M. C., Detroit, Mich.
Vandersluis, W. M., Sig. Eng., I. C., Chicago.
Van Hagan, L. F., Asso. Prof., U. of Wis., Madison, Wis.
Vaughan, G. W., Eng. M. W., N. Y. C., New York.
Wachter, R. E., Asst. Eng., Mo. Pac., St. Louis, Mo.
Wait, B. A., Div. Eng., C. R. I. & P., Cedar Rapids, Iowa.
Wallace, D. A., Chicago Ry. Terminal Commission, Chicago.
Walsh, G. R., Asst. Eng., Mo. Pac., St. Louis, Mo.
Walter, F. G., Jr., Asst. Eng., I. C., Chicago.
Warden, R. E., Asst. Eng., M. P., Little Rock, Ark.
Webb, G. H., Ch. Eng., M. C., Detroit, Mich.
Weir, John M., Ch. Eng., K. C. Sou., Kansas City, Mo.
Williams, W. D., Chief Engineer, C. N., Van Wert, O.
Wilson, C. A., Consulting Engineer, Cincinnati, O.
Woodbury, W. H., Val. Eng., D. & I. R. & D. M. & N., Duluth, Minn.
Wurzer, E. C., Div. Eng., M. C., Detroit, Mich.
Yeaton, F. D., Asst. Eng., C. M. & St. P., Chicago.

Guests

Anderson, Burt T., Asst. Sig. Engr., D. L. & W., Hoboken, N. J.
Ayers, L. C., Asst. Supt., N. & W., Crew, Va.
Bennett, W. R., Track Supvr., Wabash, Montpelier, Ohio.
Breswinger, S. J., Western Soc. Engrs, Chicago, Ill. A. C.
Brodison, R. J., Tie & Track Supt., Toledo, Ohio.
Cress, E. E., Asst. Engr., Joint Com. on Stress in R. R. Track, U. of I., Urbana, Ill.
Daugherty, J., Roadmaster, Frisco, Lebanon, Mo.
Doyle, P., Supvr., B. & B., G. T., Montreal.
Drew, H., Sig. Supt., G. T., Ottawa, Ont.
Dunn, J. A., Portland Cement Association, Chicago.
Eitzen, Arthur R., American Bridge Co., Chicago.
Galvin, P., Gen. Roadmaster, M. P., Kansas City.
Ganier, A. F., N. C. & St. L., Nashville, Tenn.
Gatewood, R. J., A. T. & S. F., Wellington, Kan.
Geyer, C. J., Asst. Div. Engr., C. & O., Richmond, Va.
Gibbons, J. J., Asst. Engr. Big 4, Cincinnati, Ohio.
Graham, J., C. R. R.
Greene, C. W., Timber Treating Engr., Toledo, Ohio.
Hallsted, R. H., Gen. Roadmaster, Coffeyville, Kan.
Hardy, B., Roadmaster, C. P., Ignace, Ont.
Harryman, J., Supt. of Track, St. Albans, W. Va.
Hayes, V. R., Asst. Engr. Wabash, Decatur, Ill.
Heuncke, J. A., Asst. Engr., C. C. C. & St. L., Cincinnati, Ohio.
Heywood, A. E., Asst. Engr., Battle Creek, Mich.
Houlihan, J. C., Sec. Engr. M. of W., I. C., Chicago.
Johnson, Paul K., Asst. Engr., C. I. & W., Chicago.
Leslie, R. D., Forest Products, New York City.
Lockhart, H. K., Asst. Supvr., Penn., Philadelphia, Pa.
Longstreet, P. E., Res. Mangr., Salt Lake City.

Longwill, M. F., Div. Engr., Wabash, Montpelier, Ohio.
Look, Richard, V.-Pres. Canada Creosoting Co., Toronto, Can.
Lorenz, H. C., Asst. Engr., Cincinnati, Ohio.
Marshall, H. L., Supt. Shops, Martinsburg.
Marshall, L. C., Asst. Engr., Mo. Pac., Little Rock, Ark.
McGuigan, J. F., Roadmaster, Frisco, St. Louis.
Miner, K. L., Supvr. B. & B., N. Y. C., Ottawa, Ont.
Moss, Jerome A., Const. Engr., Chicago.
Newbir, J. A., In Charge Lumber Mechanics, Forest Products Lab., Madison, Wis.
Osborne, S. H., Div. Engr., M. P., Kansas City, Mo.
Perkins, H. M., Asst. Engr., N. P., Fargo, N. D.
Reeves, W. T., Robt. W. Hunter Engrs., Chicago.
Rayner, I. S., Asst. Sig. Engr., Pitt. L. E., Pittsburgh, Pa.
Reinert, W. A., Asst. Engr., C. & W. I., Chicago.
Riley, Frank L., Asst. Engr. of Buildings, B. & O., Baltimore.
Ring, J. E., Div. Engr., C. & O., Hinton, W. Va.
Small, E. A., Jr., A. M. Byers Co., Pittsburgh, Pa.
Smith, H. R., Pilot Engr., G. T., Detroit, Mich.
Smith, S. W., Prin. Asst. Engr., Wabash, Chicago.
Stephens, Chas., Sig. Engr., C. & O., Richmond, Va.
Talbot, K. H., Koehming Machine Co., Milwaukee.
Upson, S. C., Div. Engr., Erie, Pa.
Week, J. E., Instr. Man., G. T., Battle Creek, Mich.
Whaley, F. D., Master Carpenter, C. R. I. & P., Des Moines, Ia.
Wilk, Benj., Universal Portland Cement, Chicago.

Chilean Railway Man at Convention

Victor M. Navarette, a civil engineer of Santiago, Chile, is in attendance at the convention as a commissioner from the Chilean government and Chilean State Railways. He has been in the States three years, studying maintenance of way practices, principally on the Pennsylvania. He made his headquarters first at Trenton, and is now at New York, where he is in close touch with the operating and maintenance conditions in the congested zone between Philadelphia and New York.

He states that this study of American railways is made with a view to the ultimate establishment of uniform standards for both construction and maintenance on his home railways. A special point in question is the gage that will eventually be adopted—whether this shall be a continuation of the present predominating wide gage of 5 ft. 6 in., the less common meter gage, or a compromise of both to the standard gage of American railways. It is also intended to raise the degree of maintenance to accord with the best practice of this country with the object especially of increasing the speed in both passenger and freight service.

A large part of the purpose in the assignment of a representative to this country is to make known the wants of his government for standard materials for track construction and for equipment. The building of the present cordial relations existing between the two governments will, it is thought, be furthered by a broader interchange of trade.

It will be interesting to engineers to recall that the first railway constructed in Chile was built by an American named Wheelwright from Massachusetts as early as 1842, which beginning has expanded into a system traversing every part of this country. The line between Valparaiso and Santiago is laid with 110-lb. rail of nearly A. S. C. E. section, known as Chilean State Railways section, and carries a daily traffic of 100 trains. Mr. Navarette is in daily attendance at the convention and at the Coliseum, studying the exhibit of the National Railway Appliances Association, which has impressed him as remarkably complete and progressive.

An Important Change

Control of the Westinghouse, Church, Kerr & Company has been purchased by Dwight P. Robinson, formerly of Stone & Webster.

B. & B. Men Meet

The executive committee of the American Railway Bridge and Building Association met in room A-6 of the Congress Hotel at 5 o'clock yesterday afternoon to hear the report of the arrangements committee relative to the Atlanta convention. After extended discussion it was decided to postpone the convention one week to avoid conflicts. The annual meeting will therefore be held at Atlanta, Ga., on October 26-28. A committee was also appointed to draft amendments to the constitution for presentation at the annual meeting.

A. R. E. A. Attendance

During yesterday's afternoon session of the American Railway Engineering Association, the announcement was made by the chairman that 531 members were in attendance. This compares with a total attendance of 425 last year.

We Hope for 21 More

E. H. Fritch has just completed 21 years' continuous service as secretary of the A. R. E. A.

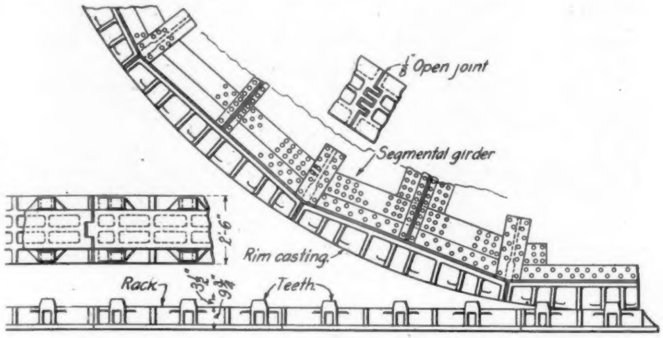
A Double-Leaf Bascule Span Designed as a Three-Hinged Arch

Double-leaf cantilever lift bridges so commonly used for highway structures have not been generally adopted by the railroads on account of the greater deflection of the cantilever. One means of overcoming this objection is to introduce arch action by bringing the two leaves together at a considerable elevation above the points of support on the abutments or piers. Particular interest in this method is aroused at this time through the erection of a long-span structure of this type carrying electric railway and street traffic across the Tennessee river at Chattanooga, Tenn. This structure affords a clear channel width of 300 ft. and as seen in the photograph is a Scherzer rolling lift bridge which acts as a double cantilever for dead loads and as a three-hinged arch for live loads, the two leaves forming riveted arch trusses from which the floor is suspended.

A particularly notable feature in this design is the manner in which the counterweights have been treated to give a minimum of difficulty in the æsthetic proportioning of the structure which, to all intents and purposes, is an arch bridge when the spans is closed. The crown contact or hinge consists of 12-in. pins mounted in the truss ends of one leaf and brought to bearing in cast steel sockets in the other leaf. One pin is located midway between the top and bottom chords of each truss in a heavy web construction that unites them at the crown. The bridge is operated electrically with control from one side of the channel and in about 1½ min. To allow the electrical operating equipment sufficient latitude to enable these pin bearings at the crown to come in contact properly, a form of dovetail mechanism has been provided at the ends of the two leaves in the plane of the floor system. Since this portion of the structure comes in close proximity first when the span is being closed, this dovetail arrangement serves to guide the two leaves so that they are at sufficiently near the same elevation as the spans come together. This operation is entirely automatic, no locking machinery is necessary.

In a movable bridge of these proportions (each leaf

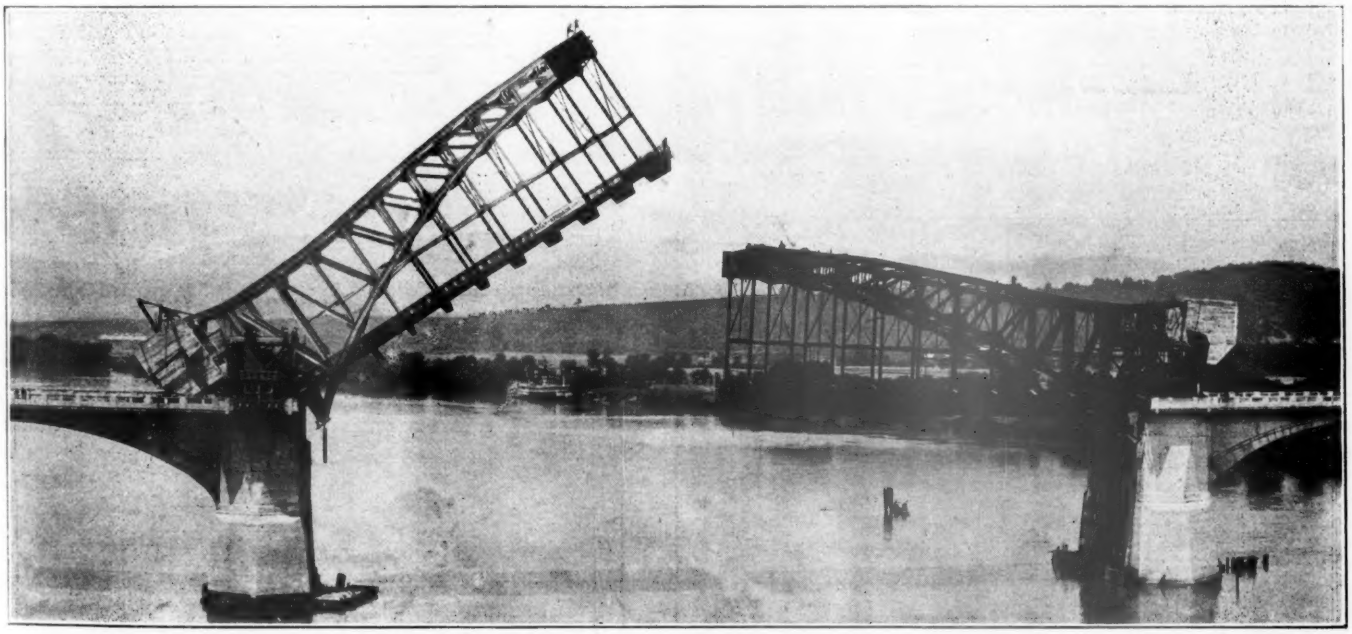
weighs 4,600,000 lb.) heavy construction is required in the rockers or segmental girders on which the bridge operates. The drawing illustrates this type of construction. Instead of building the girders to the curve of the rockers with a relatively thin rocker shoe, as was done in a large part of the earlier bridges of this type, the girders in this case are segmental, that is, with their flanges formed to the chords of the rocker curve while



The Segmental Girder with Its Cast Steel Rim and the Rack

the actual curve is formed by relatively thick cast steel tires. This form of construction not only affords a better distribution of the bearing pressures, but permits of much simpler construction in the structural steel girders which are built to straight lines rather than to the curve. It will be noted further that the joints between the ends of these tire sections are overlapped and that diaphragms are placed over these joints, as the rocker or girder to which these castings are attached is of structural steel plate girder construction supported at its ends and subject to deflection. The joints between the tire sections are open so as not to take flange stress. This same form of construction was used recently in the Petty Island bridge of the Pennsylvania railroad, a single-leaf bascule span in the Delaware river at Philadelphia.

The design for the entire bridge was made by B. H. Davis, consulting engineer, New York City, with J. E. Greiner, Baltimore, as consulting engineer for the project. The lift span design was prepared by the Scherzer Rolling Lift Bridge Company of Chicago.



The Double Leaf Span of the Tennessee River Bridge at Chattanooga

Improvements in Welding and Cutting Torches

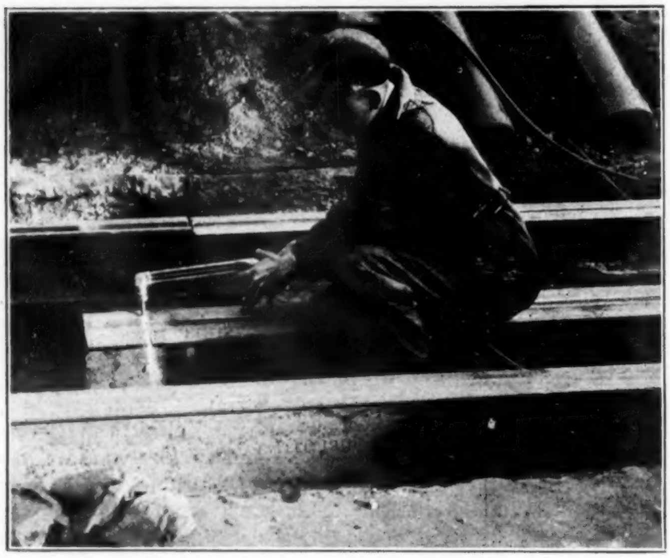
Of interest to railroads using oxy-acetylene welding and cutting equipment is the improvement made during the year in the apparatus used for this process by the Air Reduction Sales Company, New York City, which has developed new apparatus consisting of four different models of torches adapted for general welding and cutting. These models are made up in various lengths and angles of head and the nature of these new torches will be understood from the description of two of them which follows.

In the Airco "A" torch, which is used for general welding, the oxygen and acetylene gases are mixed virtually at the theoretical ratio of one part acetylene and one part oxygen. The possibility of flashbacks or backfires has been avoided owing to the method of mixing the gases in the torch and to the design of the structure itself. The method involves the introduction of acetylene at a pressure higher than that of the oxygen behind the mixing point so that if the tip is obstructed in any manner the mixture within it is enriched in acetylene and the rate of flame propagation in the discharge passage is automatically reduced. As soon as the obstruction is removed the original ratio of aceylene to oxygen is restored. The gas pressures recommended for the Airco torch are sufficiently low for safety, but are high enough so that the operator is insured control over both the oxygen and acetylene pressures as well as the quantities of these gases used.

In this torch the acetylene passages are directed to a common point—the point of mixing of the oxygen and acetylene. The oxygen is conveyed to this point by a single passage. There is no mixing chamber or expansion chamber in the torch. The tip orifice or passage is a straight drilled hole. The gases mix at the entrance to this passage, co-mingle and emerge from the tip in this state. The aceylene passages vary both in number and size with the diameter of the discharge passage in the tip, and are proportioned to the size of this passage and of the oxygen passage in the torch head. When the operator changes tips for different classes of work it is

necessary merely to adjust the regulators to the pressures plainly indicated on the handle of the torch.

The approximate pressure in pounds per square inch, speed of welding in feet per hour, consumption of gases

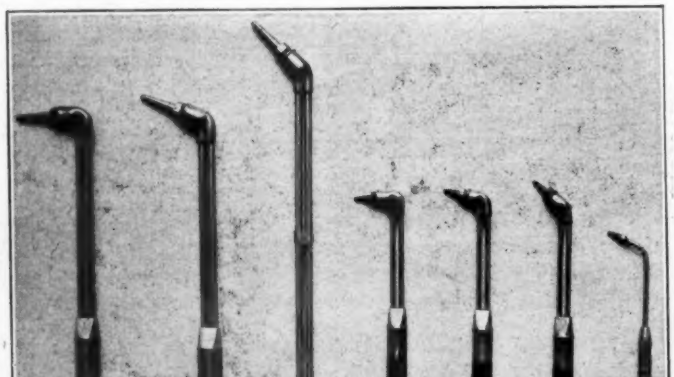


Cutting a Rail with Calorene Gas

in cubic feet per hour and the thickness of metal that can be cut by each of the 10 tips furnished for the Airco "A" torch are indicated below:

Thickness of Metal	Size of Tip	Pressure, Lb. per Sq. In. Oxy.	Pressure, Lb. per Sq. In. Acety.	Per Hour: Speed of Weld in Ft. Best Condition	Per Hour: Speed of Weld in Ft. Shop Practice	Per Hour: Gas Consumption in Cu. Ft. Oxy.	Per Hour: Gas Consumption in Cu. Ft. Acety.
1/32 to 1/16 in.	1	2	2½	21	17	2.8	2.6
1/16 to 3/32 in.	2	2	2½	17	14	4.2	3.9
3/32 to 1/8 in.	3	2	2½	14	11½	7.2	6.7
1/8 to 1/4 in.	4	2½	3	9	7	12.5	11.5
1/4 to 3/8 in.	5	3¼	4	6	4½	18.2	17.0
3/8 to 1/2 in.	6	4	5	4½	3	25.9	24.4
1/2 to 5/8 in.	7	4¾	6	3	2	37.8	35.0
5/8 to 3/4 in.	8	5¾	7	2	1¼	53.6	50.0
3/4 to 1 in.	9	6½	8	1½	1	67.2	62.5
Heavy	10	7¼	9	..	..	79.1	73.8

The Airco "B" torch is designed to meet the demand for a light torch for use in work which requires opera-



New Airco Welding Torches

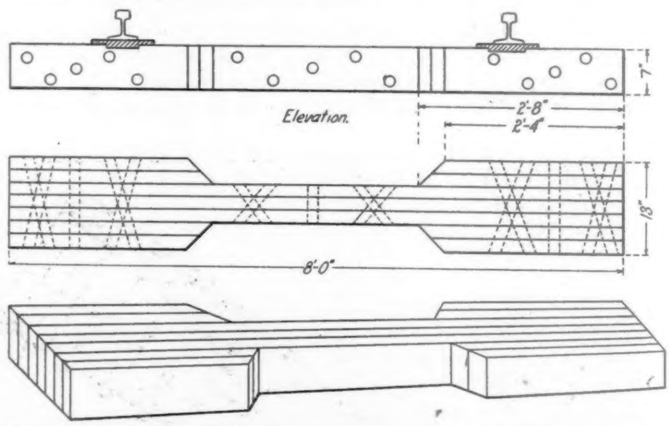
tors to weld continuously in one position and where a smaller flame than is furnished by the Airco "A" torch can be used. The approximate pressure in pounds per square inch, speed of welding in feet per hour and consumption of gases in cubic feet per hour and the thickness of metal that can be cut by each of the five tips for the Airco "B" torch are indicated below:

Thickness of Metal	Size of Tip	Pressure, Lb. per Sq. In. Oxy.	Pressure, Lb. per Sq. In. Acety.	Per Hour: Speed of Weld in Ft. Best Condition	Per Hour: Speed of Weld in Ft. Shop Practice	Per Hour: Gas Consumption in Cu. Ft. Oxy.	Per Hour: Gas Consumption in Cu. Ft. Acety.
Under 1/32 in.	1	2	2½	26	22	2.0	1.89
1/32 to 1/16 in.	2	2	2½	21	17	2.8	2.64
1/16 to 3/32 in.	3	2	2½	17	14	4.5	4.25
3/32 to 1/8 in.	4	2½	3	14	11½	6.3	5.90
1/8 to 1/4 in.	5	3	4	9	7	9.1	8.50

A Sectional or Laminated Cross-Tie

ONE OF THE RECENT developments in the railway cross-tie field is a new sectional or laminated tie manufactured by the Revert Sectional Tie Company, Reno, Nev., for use in main line or passing tracks. The Revert Sectional tie, as it is called, is composed of small pieces of sawn lumber assembled and fastened together so as to form a tie of the required size, thereby affording an outlet for material which otherwise would have little commercial value.

The main body of the tie is made up of three pieces of 2-in. by 8-in. surfaced lumber 8 ft. long, which are reinforced at each end by four pieces of similar material of the same width and thickness. These pieces are placed two on a side and are 28 in. and 32 in. long, respectively, the ends toward the center having a 1 to 1 mitre. The maximum width of the tie thus constructed from 2-in.



Construction Plan Showing Arrangement of Dowel Pins, Etc.

stock is approximately 13 in. and the minimum about 6 in., the mitred end pieces forming a tapered shoulder at each end and on both sides. After being cut to shape, each piece is treated with a preservative to insure a uniform penetration in the tie when it is completely assembled.

After the treatment, the parts of the tie are assembled, held in clamps under heavy pressure and 15 one-inch wooden dowels inserted to bind the pieces firmly together as a unit, 12 being driven on a diagonal and three straight across as shown in the illustration. A special tie-plate is used which overlaps the edges and further assists in holding the parts, besides furnishing a larger bearing surface for the rail.

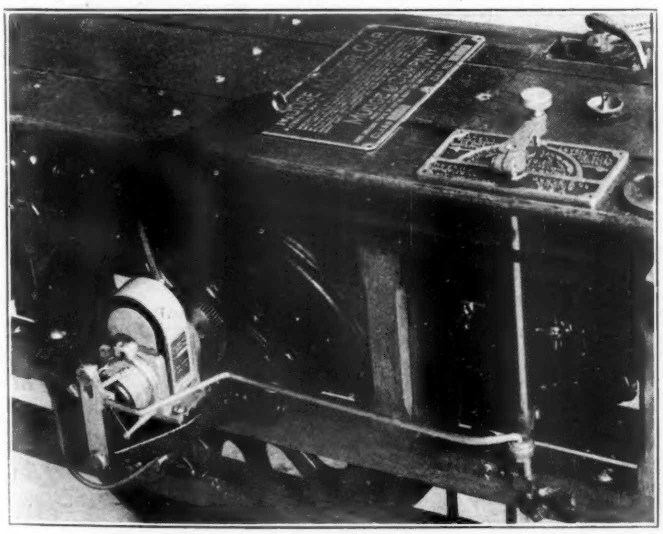
A comparison of the lumber in the Revert tie with the amount in a 7-in. by 10-in. by 8-ft. one-piece tie shows a saving of approximately 5,000 b.m. ft. per mile of track and an increased rail bearing surface of about 333 lineal ft. per mile. The tie is now being tested by the Southern Pacific on a section of line near Reno, following its use over a number of years on the logging railroad of the Verdi Lumber Company, where it was subjected to heavy rains, snows and frosts with satisfactory results, and without any separation of the pieces composing the tie.

Spikes were found to hold equally as well in the new tie as in a one-piece tie, while greater life was obtained through the increased bearing surface under the rail, the increased penetration of the preservative and the greater strength of the tie. It was found that the shoulders of the tie practically eliminated all lateral movement on tangents or curves.

A Test Installation on the Southern Pacific

Improved Ignition on Mudge Motor Cars

The new Mudge E-1 motor car manufactured by Mudge & Company, Chicago, is now being equipped with a magneto ignition. The magneto is a high-tension Berling magneto with weather and dustproof case and is mounted on a casting attached to the upper frame rail of the car, as shown in the illustration. The application of the magneto is such that the car can be run in either direction, the magneto timing lever on the seat board being turned to point in the direction in which the car is to run. The operation of the spark control is very simple, the timer being advanced and retarded the same as with the vibrating coil ignition system. By placing the magneto timing lever in a neutral position, that is, half way between the forward and reverse running positions, the ignition may be cut out without opening the coaster valve, thus causing the engine to act as a brake. This, however, does not interfere with the ignition cut-out controlled by the coaster valve-operating mechanism which is entirely independent of the other. The entire arrangement is simply and substantially mounted with controlling levers of large size.

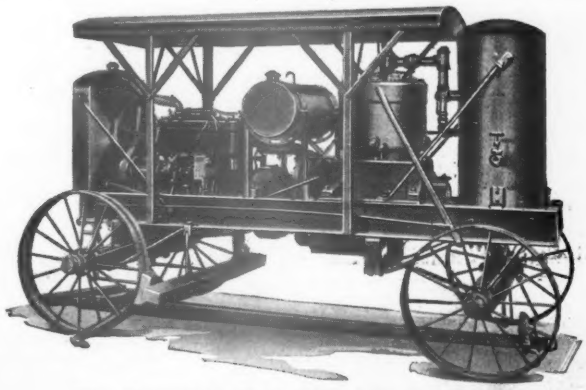


Photograph Showing the Improved Ignition

A Portable Gasoline-Driven Air Compressor

The increasing popularity of the gasoline engine and other forms of internal combustion motors has led to their general adoption as a source of power, particularly where portability is desired. Such an installation has been developed by the Sullivan Machinery Company, Chicago, in the form of a portable air compressor, which consists of a two-cylinder air compressor with receiver tank driven by a four-cylinder gasoline motor. All parts of the unit are mounted on a steel frame supported by four steel wheels with a gage of 4 ft. 8 in., the total weight of the equipment being 4,500 lb. This permits it to be employed on numerous maintenance and construction jobs where the use of compressed air in comparatively large quantities would be advantageous, but otherwise either impractical or expensive on account of the attendant costs of making temporary compressor installations or of spurring out a compressor car.

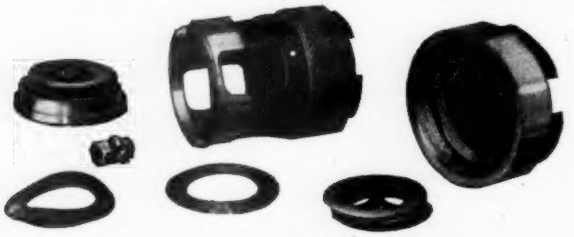
The compressor, which is mounted near one end of the frame, is of the two-cylinder, single acting, single stage, vertical type and has a displacement capacity of 150 cu. ft. per min. of free air with a terminal pressure of 100 lb. at 400 r.p.m. The cylinders measure 8 in. by 6½ in. and are water-cooled by hopper jackets, lubrication being secured by a force feed oil pump inclosed in the crank case and arranged to deliver oil under pressure to all bearings. Any oil thrown off by the crank pin is prevented from entering the cylinder by baffle plates and as a further protection, the lower ends of the piston are provided with "wiper" rings to prevent excess oil from accumulating on the cylinder walls. The air valves are of the wafer plate type and are located radially with respect to the axis of the cylinder, close to its head and held in place by flat circular leaf springs. Both valves and springs are made of high grade tempered spring steel. The valves open against guard plates, which are designed to give a wide port opening with the minimum clearance loss and without restricting the admission or discharge of the air to or from the cylinders, yet are easily accessible by the removal of screw plugs.



The Complete Unit Mounted on Wheels

The power is applied to the compressor through an internal gear cut in the heavy square rim flywheel mounted on the compressor crank shaft which engages with a pinion on the shaft of the gasoline engine, the application of the power being controlled by an automobile type of disk clutch. The clutch shaft is supported at the flywheel end by a ball bearing and at the pinion end by a high

duty roller bearing. The motor is of the "en bloc" type with a removable cylinder head and provided with a three-point suspension. Ignition is produced by a high tension magneto equipped with an impulse starter. The carburetor is of standard make and fitted with a governor to maintain constant speed. The radiator located at the rear end



The Wafer Type Valve and Cage

of the frame is of large size and strongly braced. The entire unit is protected by a sheet metal canopy to which are attached canvas side curtains which can be lowered when the outfit is not in use.

A New Adjustable Rail Brace

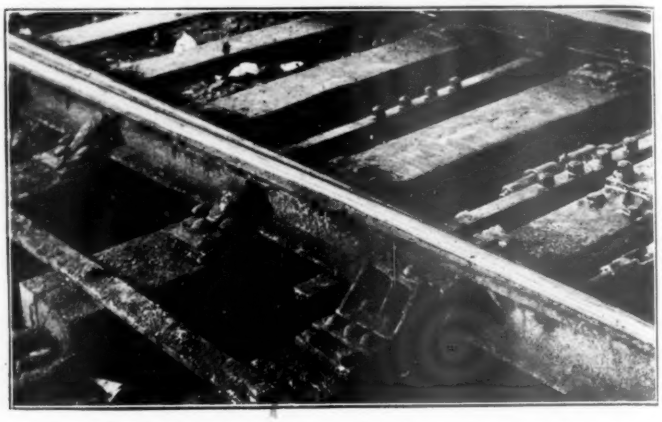
The Coleman Railway Supply Company, New York City, has recently brought out a new design of rail brace which is adjustable in steps of $\frac{3}{32}$ in. for a total adjustment of $\frac{5}{8}$ in. and which is comprised of but three parts; a bracket, which is the fixed member, a wedge, which is the loose member, and a split pin for holding the bracket and wedge in place. These parts and the manner in which they are applied are shown in the photographs. The loose member is wedge-shaped and has a groove which is designed to fit a tongue provided in the fixed member. The wedge, when applied, is driven in until all play between the rail and the bracket is taken up.

The adjustments are made by means of a series of one-half diameter holes provided in the wedge and in the

The Wedge Member in Position to Be Driven Home

bracket. These half holes are on different centers in each part of the device, but bear a certain relation to each other, so that, with the wedge driven to adjustment, a full diameter hole is formed of the half diameter holes in either part. Into this hole is placed a large split pin which, when spread, acts as a cotter and holds the two members in place.

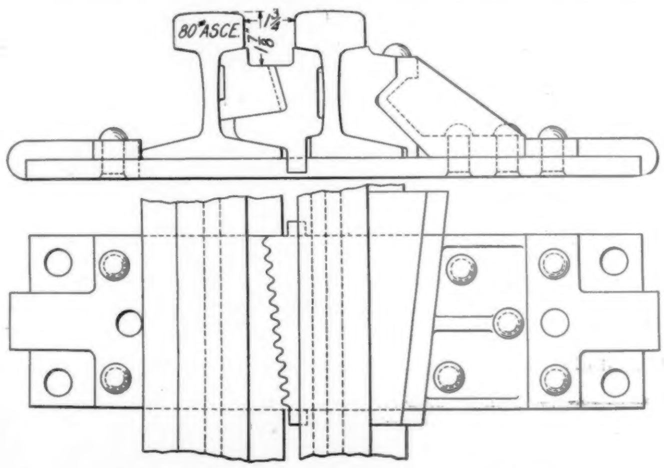
The pin, which is $\frac{7}{8}$ in. in diameter, is solid for about half its length, being slotted at the lower end. This gives a solid $\frac{7}{8}$-in. section of iron to hold the bracket and wedge together. The slot is of sufficient width to make spreading easy and it requires only a slight pull



The Adjustable Rail Brace in Service at a Switch Point

with a claw-bar to withdraw the pin from the hole when another adjustment is to be made.

The bracket and pin are of a standard size for all rails,



Combination Guard Rail Clamp and Tie Plate

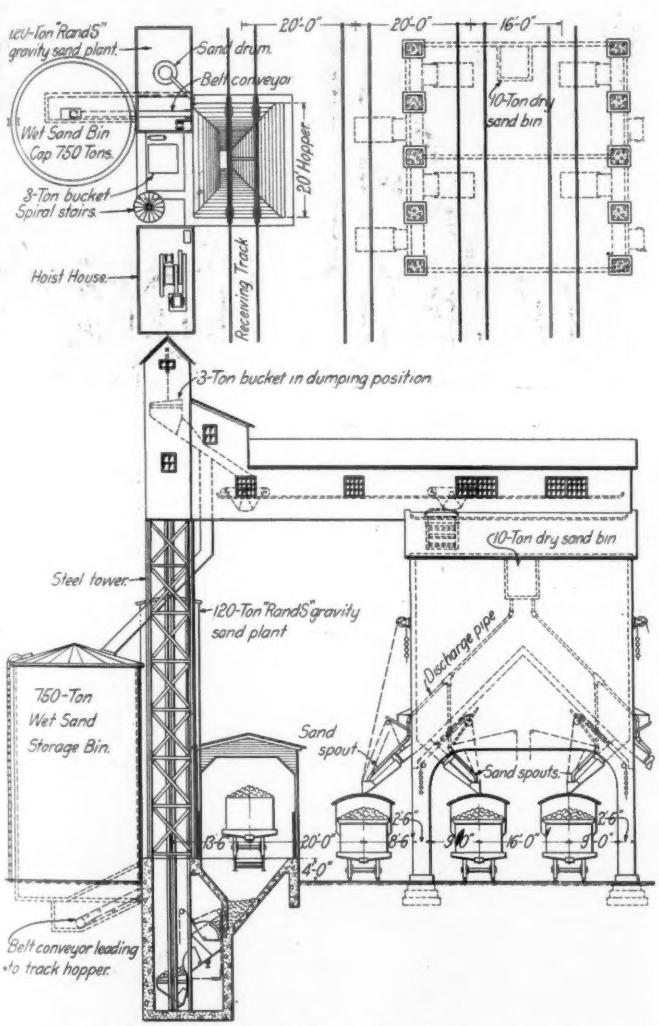
while the dimensions of the wedge are varied with the different rail sections. The device is used both on switch points and guard rails.

A Large Capacity Wet Sand Storage Plant

The Roberts & Schaefer Company, Chicago, is now completing a large new coaling and sanding station for the Lehigh Valley at Ashmore, Pa., which has for one of its main features the adoption of a wet sand storage arrangement which insures an adequate supply of sand for winter use and eliminates practically all manual labor incident to its handling. The sand itself is stored in a circular reinforced concrete tank with a storage capacity of 750 tons. While the design of the tank merits attention, the chief point of interest lies in the installation and operating methods of this new winter storage, fireproof, sand-handling and drying plant because the entire operation of storing, drying and handling of the sand is performed without shoveling or hand labor with the possible exception of unloading the cars.

The Ashmore plant consists of a 750-ton reinforced concrete coaling station serving four tracks, a 120-ton RandS gravity sand plant and the 750-ton wet sand stor-

age bin. An automatic electric hoist with a three-ton bucket is used for both the wet sand and the coal, which are unloaded into a track hopper, flowing by gravity through a three-ton Schraeder automatic measuring feeder to the hoisting bucket. The sand, after being elevated, is discharged automatically and falls by gravity down a steel spout leading to the storage bin, which is approximately 24 ft. 6 in. in diameter and 45 ft. high. In reclaiming sand from the wet storage bin a large gate is opened, allowing the sand to fall by gravity, aided by a revolving feeder operating at about 10 r.p.m. on a 16-in. belt conveyor traveling at a rate of about 350 ft. per min. This conveyor, which is driven by a 10 h.p. electric motor, has an over-all length of 27 ft. and carries the sand direct to the track hopper, whence it is again elevated by the three-ton bucket hoist. In this cycle, however, the sand is discharged into a steel chute leading to the 120-ton storage bin over the RandS gravity sand-drying plant. By this arrangement the sand can be elevated into this bin over the dryer, either from the cars or from storage.



Sand Storage Bin and General Distribution System

From the 120-ton bin the sand flows by gravity through two large discharge spouts, controlled by gates, into two Beamer steam sand dryers which run without attention. After the sand has passed through the steam drying coils, it drops into a steel hopper, where it is cleaned by gravity, the clean, dry sand falling into automatic sand drums which require about two hours to fill. When the drums are completely filled the sand is blown by compressed air up into the 10-ton dry sand storage bin over the top of the coaling pocket, whence it flows by gravity through the moisture-proof undercut sand valves and telescoping spouts to the locomotives on the four tracks.

A Portable Electric Flood Light

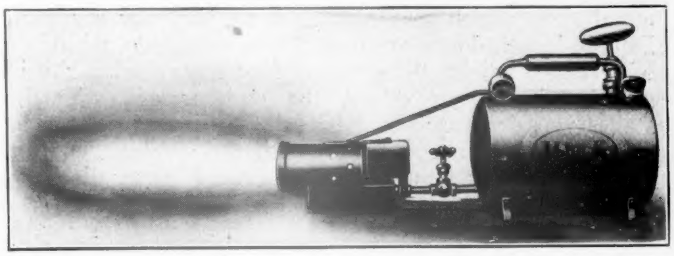
Working at night under overhead lights has always been a handicap to workmen and in many instances is the underlying cause of errors or inaccuracies. One of the latest devices introduced for the purpose of bettering such lighting conditions and to secure better illumination under the varied circumstances met with in railway shops and gravel pits, on construction work, at wrecks, etc., is a portable electric flood light manufactured by the Alexander Milburn Company, Baltimore, Md.

The New Light and Stand

This light consists of an enameled reflector 15 in. in diameter, mounted on a standard and supported by tripod legs, the total overall height being 68 in. The spread of the legs is 28 in. and the height of the device with the standard lowered is 38 in., the entire unit weighing about 20 lb. The upper end of the standard is adjustable, so that the reflector can be set at any desired angle or height from the level of the ground to a maximum of nearly 6 ft., the reflector being free to revolve in any desired direction. By using a 100-watt lamp a 60-ft. ray can be projected, making it adaptable for a wide variety of requirements.

A Reinforced Thawing Torch

During cold weather a thaw torch becomes an important and much-used appliance which is commonly subjected to rough usage. It may also be dropped or knocked against other objects while in use. While the burner may not break under such service the connection is eventually weakened, interfering with the efficiency of the burner. In recognition of the abuse which a torch receives, the Hauck Manufacturing Company, Brooklyn, N. Y., has added a strong bracket to its No. 55 thawing torch which forms a protection against knocking or dropping.



The Bracket Protects the Burner

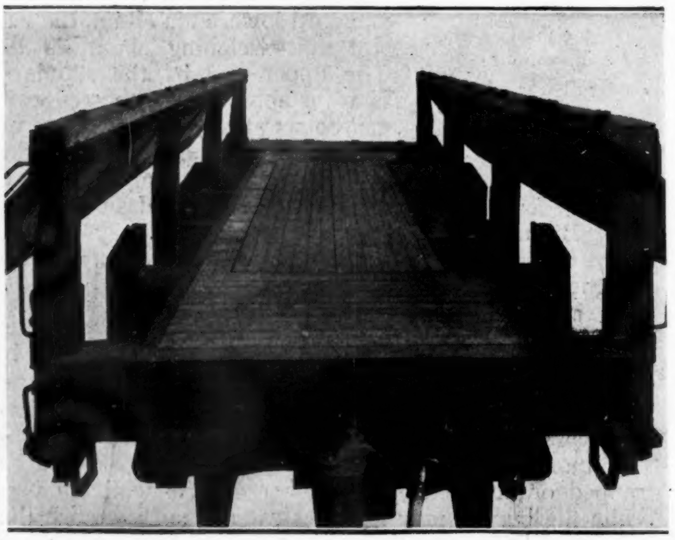
This bracket consists of a piece of heavy-gage band iron which is fastened at one end well out on the burner and extends back to the tank, where it is fastened at the point where the handle joins the tank proper, thus forming a brace that removes the major portion of any strain from the pipe connection. The complete thawing torch

has a 1½-gal. rust-proof steel tank equipped with hand pump and pressure gage. The length of the flame which can be projected is 22 in. on a consumption of three quarts of kerosene an hour. The complete outfit weighs about 11 lb. and is recommended by its makers for such work as thawing out switchpoints, interlocking ashpan slides, air openings, injectors, links and other miscellaneous work.

The Improved Hart Convertible Car

The Rodger Ballast Car Company, Chicago, has added several important improvements to its ballast car which are of interest to railroad men handling ballasting and construction work. The improvements in general consists of the provision of edges sloping downward and outward along the sides of the floor, an increased length of the vertical side doors and opening, with a corresponding reduction in the number of supporting stakes, a new method of operating the side door mechanism and a new arrangement for the guidance and support of the unloading plow.

The floor of the improved car is horizontal to within eight inches of the sides when it slopes down and out, extending beyond the edge of the door. The edge of the floor so formed by this method of construction is reinforced and protected at the point of the change by a metal strip which also acts as a support for the plow. Double length doors are used, three on a side, which are of greater height than those formerly used. By installing the longer doors, the number of supporting stakes was decreased to four full length and three short ones, and this, in connection with the sloping floor and the higher doors, has resulted in a much larger discharge opening and a consequent quicker release of the pressure. The short side stakes act chiefly as guides for the plow in connection with the extension from the edge of the horizontal floor to each stake and with the reinforcing edge strip, the latter acting as the main support for the plow. The doors are held closed by a heavy bar on each side, which differs from the old arrangement in that it is straight between ends and is attached to the side doors, instead of to the underframe, by means of large hooks placed along the line of the greatest strain. In locking, the shaft is raised to engage with a series of inverted hooks supported on the side stakes, the shape of the tip on the lower hook forming a notch with the upper hook which tends to hold the shaft in position regardless of the pressure on the door. This arrangement makes it possible to unload the material on either side as desired or on both sides at the same time and has the additional advantage that the operating mechanism cannot be fouled by the material unloaded.



End View With Doors Open, Showing Sloping Edges, Etc.

The main improvement in the car, however, lies in the type of floor construction, for in actual operation when the side doors are released, the bottom layer of the material for a distance of nearly 10 in. from the sides of the car is released and falls out naturally by gravity, causing a large amount of other material to cave and follow it out. This quantity varies, of course, with the material being handled, but runs as high as 40 per cent of the total load in some instances, resulting in the release of the sides of the car from any pressure and an increase in the ease with which the unloading plow can be operated and the elimination of practically all liability of boulders, roots, stones or earth, jamming between the plow and the stake. Any material that might lodge on the plow runways or guides is swept into the pockets by the plow as it passes along, thus making it possible to keep the plow on the floor at all times and to secure practically 100 per cent unloading.

Hart Convertible Cars Unloaded by Side Plow

The Ballast Sliding Out by Gravity When Doors Are Released

This car is easily converted for use as a center dump car for the distribution of ballast, etc., along the center line of the track. When used in this manner the operating procedure is the same as with the earlier model, the only change being that the control of the flow from the bottom can be regulated more accurately.